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SCIENCE TEACHING

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THE GARY PUBLIC SCHOOLS

SCIENCE TEACHING

BY

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INTRODUCTION

THE GARY PLAN

In the last few years both laymen and professional educators have engaged in a lively controversy as to the merits and defects, advantages and disadvantages of what has come to be called the Gary idea or the Gary plan. The rapidly increasing literature bearing on the subject is, however, deficient in details and too often partisan in tone. The present study was undertaken by the General Education Board at the request of the Gary school authorities for the purpose of presenting an accurate and comprehensive account of the Gary schools in their significant aspects.

In the several volumes in which the main features of the Gary schools are separately considered, the reader will observe that, after presenting facts, each of the authors discusses or—in technical phrase—attempts to evaluate the Gary plan from the angle of his particular interest. Facts were gathered in a patient, painstaking, and objective fashion; and those who want facts, and facts only, will, it is believed, find them in the descriptive and statistical portions of the respective studies. But the successive volumes will discuss principles, as well as state facts. That is, the authors will not only describe the Gary schools in the frankest manner, as they found them, but they will also endeavor to interpret them in the light of the large educational movement of which they are part. An educational conception may be sound or unsound; any particular effort to embody an educational conception may be adequate or inadequate, effective or ineffective. The public is interested in knowing whether the Gary schools as now conducted are efficient or inefficient; the public is also interested in knowing whether the plan as such is sound or unsound. The present study tries to do justice to both points.

What is the Gary plan?

Perhaps, in the first instance, the essential features of the Gary plan can be made clear, if, instead of trying to tell what the Gary plan is, we tell what it is not. Except for its recent origin and the unusual situation as respects its foreign population, Gary resembles many other industrial centers that are to be found throughout the country. Now, had Gary provided itself with the type of school commonly found in other small industrial American towns, we should find there half a dozen or more square brick "soap-box" buildings, each accommodating a dozen classes pursuing the usual book studies, a playground, with little or no equipment, perhaps a basement room for manual training, a laboratory, and a cooking room for the girls. Had Gary played safe, this is the sort of school and school equipment that it would now possess. Provided with this conventional school system, the town would have led a conventional school life—quiet, unoffending, and negatively happy—doing as many others do, doing it about as well as they do it and satisfied to do just that.

As contrasted with education of this meager type, the Gary plan is distinguished by two features, intimately connected with each other:

First—the enrichment and diversification of the curriculum;

Second—the administrative device that, for want of a better name, will be tentatively termed the duplicate school organization.

These two features must first be considered in general terms, if the reader is to understand the detailed description and discussion.

As to the curriculum and school activities. While the practice of education has in large part continued to follow traditional paths, the progressive literature of the subject has abounded in constructive suggestions of far-reaching practical significance. Social, political, and industrial changes have forced upon the school responsibilities formerly laid upon the home. Once the school had mainly to teach the elements of knowledge; now the school is charged with the physical, mental, and social training of the child. To meet these needs a changed and enriched curriculum, including community activities, facilities for recreation, shop work, and household arts, has been urged on the content side of school work; the transformation of school aims and discipline on the basis of modern psychology, ethics, and social philosophy has been for similar reasons recommended on the side of attitude and method.

These things have been in the air. Every one of them has been tried and is being practised in some form or other, somewhere or other. In probably every large city in the country efforts have been made, especially in the more recent school plants, to develop some of the features above mentioned. There has been a distinct, unmistakable, and general trend toward making the school a place where children "live" as well as "learn." This movement did not originate at Gary; nor is Gary its only evidence. It is none the less true that perhaps nowhere else have the schools so deliberately and explicitly avowed this modern policy. The Gary schools are officially described as "work, study, and play" schools—schools, that is, that try to respond adequately to a many-sided responsibility; how far and with what success, the successive reports of the Gary survey will show.

It must not, however, be supposed that the enriched curriculum was applied in its present form at the outset or that it is equally well developed in all the Gary schools. Far from it. There has been a distinct and uneven process of development at Gary; sometimes, as subsequent chapters will show, such rapid and unstable development that our account may in certain respects be obsolete before it is printed. When the Emerson school was opened in 1909, the equipment in laboratories, shops, and museums, while doubtless superior to what was offered by other towns of the Gary type, could have been matched by what was to be found in many of the better favored larger towns and cities at the same period. The gymnasium, for example, was not more than one third its present size; the industrial work was not unprecedented in kind or extent; the boys had woodwork, the girls cooking and sewing. But progress was rapid: painting and printing were added in 1911; the foundry, forge, and machine shop in 1913. The opportunities for girls were enlarged by the addition of the cafeteria in 1913. The auditorium reached its present extended use as recently as the school year 1913–14. The Froebel school, first occupied in the fall of 1912, started with facilities similar to those previously introduced piecemeal into the Emerson.

These facilities, covering in their development a period of years, represent the effort to create an elementary school more nearly adequate to the needs of modern urban life. The curriculum is enriched by various activities in the fields of industry, science, and recreation. Questions as to the efficiency with which these varied activities have been administered will be discussed by the various contributors to the present study. Meanwhile, it is perhaps only fair to point out that the modern movement calls not only for additions to, but eliminations from, the curriculum and for a critical attitude toward the products of classroom teaching. How far, on the academic side, the Gary schools reflect this aspect of the modern movement will also presently appear.

The administrative device—the "duplicate" organization, noted above as the second characteristic feature of the Gary plan—stands on a somewhat different footing, as the following considerations make plain.

Once more, Mr. Wirt was not the inventor of the intensive use of school buildings, though he was among the first—if not the very first—to perceive the purely educational advantage to which the situation could be turned. The rapidity with which American cities have grown has created a difficult problem for school administrators—the problem of providing space and instruction for children who increase in number faster than buildings are constructed. The problem has been handled in various ways. In one place, the regular school day has been shortened and two different sets of children attending at different hours have been taught daily in one building and by one group of teachers. Elsewhere, as in certain high schools, a complete double session has been conducted. The use of one set of schoolrooms for more than one set of children each day did not therefore originate at Gary.

Another point needs to be considered before we discuss the so-called duplicate feature of the Gary plan. In American colleges, subjects have commonly been taught by specialists, not by class teachers. The work is "departmentalized"—to use the technical term. There is a teacher of Latin, a teacher of mathematics, a teacher of physics, who together instruct every class—not a separate teacher of each class in all subjects. Latterly, departmentalization has spread from the college into the high school, until nowadays well organized high schools and the upper grades of elementary schools are quite generally "departmentalized," i.e., organized with special teachers for the several subjects, rather than with one teacher for each grade.

Out of these two elements, Gary has evolved an administrative device, the so-called duplicate school, which, from the standpoint of its present educational significance, does indeed represent a definite innovation.

For the sake of clearness, it will be well to explain the theory of the duplicate school by a simplified imaginary example:

Let us suppose that elementary school facilities have to be provided for, say, 1,600 children. If each class is to contain a maximum of 40 children, a schoolhouse of 40 rooms would formerly have been built, with perhaps a few additional rooms, little used, for special activities; except during the recess (12 to 1:30) each recitation room would be in practically continuous use in the old-line subjects from 9 to 3:30, when school is adjourned till next morning. A school plant of this kind may be represented by Figure I, each square representing a schoolroom.

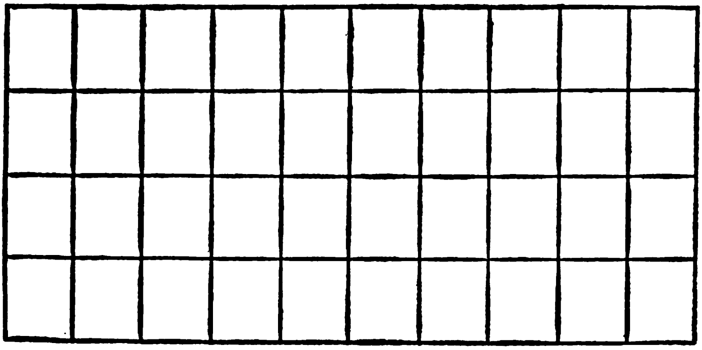
The "duplicate" school proposes a different solution. Instead of providing 40 classrooms for 40 classes, it requires 20 classrooms, capable of holding 800 children; and further, playgrounds, laboratories, shops, gardens, gymnasium, and auditorium, also capable of holding

800 children. If, now, 800 children use the classrooms while 800 are using the other facilities, morning and afternoon, the entire plant accommodates 1,600 pupils throughout the school day; and the curriculum is greatly enriched, since, without taking away anything from their classroom work, they are getting other branches also. A school thus equipped and organized may be represented by Figure II, in which A represents 20 classes taking care of 40 children each (800 children), and B represents special facilities taking care of 800 children. As A and B are in simultaneous operation, 1,600 children are cared for.

FIGURE I

REPRESENTS OLD-FASHIONED SCHOOLHOUSE

40 rooms for 40 classes, of 40 children each, i. e., facilities for the academic instruction of 1,600 children. A school yard and an extra room or two, little used, for special activities, are also usually found.



This method of visualizing the "duplicate" school serves to correct a common misconception. The plan aims to intensify the use of schoolrooms; yet it would be incorrect to say that 20 classrooms, instead of 40, as under the old plan, accommodate 1,600 children. For while the number of classrooms has been reduced from 40 to 20, special facilities of equal capacity have been added in the form of auditorium, shops, playground, etc. The 20 classrooms apparently saved have been replaced by special facilities of one kind or another. The so-called duplicate organization and the longer school day make it possible to give larger facilities to twice as many children as the classrooms alone would accommodate. The duplicate school, as developed at Gary, is not therefore a device to relieve congestion or to reduce expense, but the natural result of efforts to provide a richer school life for all children.

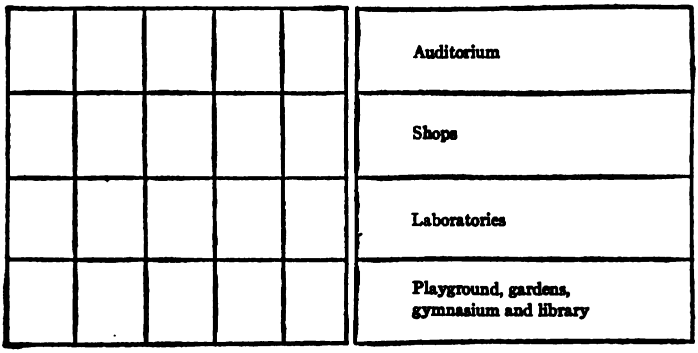
FIGURE II
REPRESENTS THE GARY EQUIPMENT

A

20 classrooms for academic instruction of 20 classes of 40 children each (800 children) in the morning hours and an equal number in the afternoon (1,600 in all daily)

B

Special facilities, taking care of 800 children in the morning hours and an equal number in the afternoon hours (1,600 in all daily)



The enriched curriculum and the duplicate organization support each other. The social situation requires a scheme of education fairly adequate to the entire scope of the child's activities and possibilities; this cannot be achieved without a longer school day and a more varied school equipment. The duplicate school endeavors to give the longer day, the richer curriculum, and the more varied activities with the lowest possible investment in, and the most intensive use of, the school plant. The so-called duplicate school is thus a single school with two different types of facilities in more or less constant and simultaneous operation, morning and afternoon.

Such is the Gary plan in conception. What about the execution? Is it realized at Gary? Does it work? What is involved as respects space, investment, etc., when ordinary classrooms are replaced by shops, playgrounds, and laboratories? Can a given equipment in the way of auditorium, shops, etc., handle precisely the same number of children accommodated in the classrooms without doing violence to their educational needs on the one hand, and without waste through temporary disuse of the special facilities, on the other? To what extent has Gary modified or reorganized on modern lines the treatment of the common classroom subjects? How efficient is instruction in the usual academic studies as well as in the newer or so-called modern subjects and activities? Is the plan economical in the sense that equal educational advantages cannot be procured by any other scheme except at greater cost? These and other questions as to the execution of the Gary plan are, as far as data were obtainable, discussed in the separate volumes making up the present survey.

The concrete questions above mentioned do not, however, exhaust the educational values of a given school situation. From every school system there come imponderable products, bad as well as good. Aside from all else, many observers of the Gary schools report one such imponderable in the form of a spiritual something which can hardly be included in a study of administration and eludes the testing of classroom work. These observers have no way of knowing whether Gary school costs are high or low; whether the pupils spell and add as well as children do elsewhere; but, however these things may be, they usually describe the pupils as characterized by self-possession, resourcefulness, and happiness to an unusual degree. While different schools and indeed different parts of the same school vary in this respect, the members of the survey staff agree that, on the whole, there is a basis of fact for these observations. Gary is thus something more than a school organization characterized by the two main features above discussed.

The reason is not far to seek. Innovation is stimulating, just as conformity is deadening. Experiment is in this sense a thing wholesome in itself. Of course it must be held to strict accountability for results; and this study is the work of persons who, convinced of the necessity of educational progress, are at the same time solicitous that the outcome be carefully observed. The fact that customary school procedure does not rest upon a scientific basis, does not willingly submit itself to thorough scrutiny, is no reason for exempting educational innovations from strict accountability. The very reverse is indeed true; for otherwise innovation may imperil or sacrifice essential educational values, without actually knowing whether or not it has achieved definite values of its own. Faith in a new program does not absolve the reformer from a watchful and critical attitude toward results. Moreover, if the innovator formulates his purposes in definite terms and measures his results in the light of his professed aims, the conservative cannot permanently escape the same process. Gary, like all other educational experiments, must be held accountable in this fashion. Subject however to such accountability, the breaking of the conventional school framework, the introduction of new subject matter or equipment, even administrative reorganization, at Gary as elsewhere, tend to favor a fresher, more vigorous interest and spirit. Defects will in the following pages be pointed out in the Gary schools—defects of organization, of administration, of instruction. But there is for the reasons just suggested something in the Gary schools over and above the Gary plan. Problems abound, as in every living and developing situation. But the problems are the problems of life, and, as such, are in the long run perhaps more hopeful than the relatively smooth functioning of a stationary school system. Thus, notwithstanding the defects and shortcomings which this study will candidly point out, the experiment at Gary rightly observed and interpreted is both interesting and stimulating.

SCIENCE TEACHING

SCIENCE TEACHING

I. SCIENCE TEACHING AS A PART OF A MODERN CURRICULUM

THERE is fairly universal assent to the opinion that since science enters so largely into modern thought, experience, and action, it should be included in any curriculum which deliberately and adequately relates to the world in which we live. A lengthened school day, better equipment, and better use of the school's environment provide increased opportunity for studies in science. In connection with science and shop work, the mere cultivation of dexterity and exercise of the senses have an undeniable value, for it is worth a pupil's while to be "handy" and certainly worth his while to be observant. Thus, simply as training for the senses, a case can be made out for work in science. In order, however, to justify the elaborateness of the outfit which Gary has installed and the seriousness with which the subject is there viewed, more than sense training must be obtained. It is, for intellectual reasons, a sound philosophy of education which insists that pupils do things rather than read about them or see them done. But mere doing of concrete tasks—whether tasks assigned in the laboratory manual or tasks from everyday life—does not in itself prolong the exercise into the intellectual region. To realize large educational value, the exercise needs to be carried far enough to bring out explicitly the intellectual side of processes. The pupil must think consecutively about the factors which he is manipulating; he must think about the causal and purposeful relations involved in the concrete processes that he is carrying out. He must eventually be able to express results in generalized form, and to deal with laws and relationships. An educational development of this kind does not take place spontaneously, as a result of the pupil's working with materials such as animals, plants, metals, a printing press, a dynamo, or a camera. In these appealing tools and objects, innumerable intellectual values and factors are involved—the origin and history of culture, the properties of materials, the application of laws and principles to the work of men and to their organization of ideas. Only a skillful instructor, pursuing a well thought out and well wrought plan, requiring interested and protracted effort on the pupil's part, can teach science so as to obtain these values from it. Unless it is so taught science teaching will not meet expectations or realize its possibilities.

Great hopes attended the introduction of science studies into education—hopes that to a considerable extent have thus far been disappointed. If we assume—as we do—that this disappointment does not really imply simply a mistaken enthusiasm on the part of those who still believe in the importance of science in educational development, several reasons may be assigned for it, viz., the lack of sufficient school time, the lack of teachers trained to know the science of common things, and the employment of unsound methods. It is probable that these factors go far to account for the unsatisfactory outcome of the early efforts to teach science in the elementary and the high schools. The subjects usually got inadequate recognition in the school schedule; often the teachers had not been properly trained; finally, the method of presentation, being excessively formal and abstract, did not lead to consideration of the things about which pupils wish and need to know.

II. SCIENCE TEACHING IN THE GARY SCHOOLS

(A) GENERAL PLAN

THE Gary school system is composed of nine schools. Two of these schools—the Froebel and the Emerson—are large and commodious modern school buildings, the former accommodating 2,087 pupils, the latter, of about equal capacity, having an enrollment of 967, both, in point of equipment, adequate to the carrying out of the Gary plan described in the introduction to this volume; the Jefferson school, with 1,011 pupils, is a remodeled building of conventional type; the Beveridge and Glen Park schools, with 683 and 315 pupils respectively, are both inferior to the Jefferson in facilities. The remaining schools are merely temporary structures. The Froebel and Emerson schools include complete elementary and high school courses; the other schools are elementary schools, the Jefferson alone comprising all of the eight elementary grades.

All the schools offer instruction in nature study and gardening in the primary grades. The Emerson and Froebel schools offer, in addition, botany, zoology, physics, and chemistry.

As far as possible the teaching is departmentalized; that is, the nature study of the primary grades is in charge of teachers chosen for that work, while the science work of the upper grades and that of the two high schools is in the hands of special teachers in the different subjects. According to the plan of organization at the time of the survey, the science work of all the Gary schools was organized as a department of science with the chemistry teacher of the Emerson school as head. In studying the organization, administration, supervision and teaching of science, it was not possible to discover or secure a comprehensive statement of purposes of the work, nor an outline of the plan of the work for the entire system. There were indeed few indications of general or unified policy. No plan or outline of work in the several subjects had been made to guide the teachers. It was rather the intention of the authorities to leave the several schools and the several teachers in any one school large freedom to determine their own purposes and to work out their own courses of instruction.

(B) TIME ALLOTMENT

The amount of time actually used in teaching science in the Gary schools is not easily determined, since the schools vary considerably and within each school the teacher is free to depart from the schedule. Since science is often taught together with English or shop work, etc., it is not possible to say exactly how much of the time belongs to science. This fact is not in itself necessarily a fault; but it renders any estimate made of the time used little more than a guess. Careful study of the school program and conference with the individual teachers of science lead to the following estimate of the number of hours of instruction in science received by the pupils in the different grades:

GRADE	HOURS
I.	89
II.	80
III.	90
IV.	57
V.	14
VI.	83
VII.	69
VIII.	85
Total	567

This table may be understood as meaning that in passing through the eight grades of the elementary schools Gary children may devote approximately 550 hours to the study of science. The number of hours undoubtedly varies considerably from grade to grade and from school to school.

On this basis science is exceeded by six subjects and exceeds six in the average amounts of time given to it.[1] Those which it exceeds are German, music, geography, writing, spelling, and history. It will be noted that the time allowance for science falls off sharply in grades 4 and 5; this is accounted for by the increased time as-

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[1] For tables showing scheduled time of all subjects, see pages 9–13.

Nature Study Room—Jefferson School

TABLE I

AVERAGE NUMBER OF HOURS ALLOTTED TO DIFFERENT STUDIES, 1915–1916

GRADE	READING	LANGUAGE[1]	SPELLING	WRITING	ARITHMETIC	GEOGRAPHY	HISTORY	SCIENCE	DRAWING AND MAN. TR.[2]	MUSIC[3]	AUDITORIUM	PHYSICAL TRAINING AND PLAY	GERMAN[4]
1	241	82	83	57	99			89	108	33	200	408	
2	239	104	69	47	117			80	111	33	200	400	
3	205	132	79	39	120			90	111	30	200	394	
4	176	118	72	38	124	15	15	57	228	20	200	337	
5	132	103	60	49	106	45	44	14	283	14	200	340	10
6	143	67	51	28	126	56	65	83	288	29	200	264	
7	102	91	54	38	123	64	95	69	209	29	200	314	12
8	85	101	28	33	143	58	120	85	267		200	240	40
Total	1,323	798	496	329	958	238	339	567	1,605	188	1,600	2,697	62

[1] Language includes the grammar of the seventh and eighth grades.

[2] Unfortunately we are unable to separate drawing from manual training or shop work. In the first two grades the allotted time is divided about equally. In the other grades, approximately one-third goes to drawing, including both freehand and mechanical, and two-thirds to shop work.

[3] The time allotment to music relates to regular music teaching, and does not include such parts of "auditorium" time as may be given to it.

[4] German is taught in Emerson and Jefferson only.

TABLE II

Jefferson Elementary School—1915–1916

Class No.	Grades in:			No. of Hours Classes Were Scheduled For:			
	Sept.	Dec.	Mar.	Nature Study	Cooking (Girls)	Sewing (Girls)	Shop (Boys)
1	1C	1B	1B	100			
2	1A	2C	1A	100			
4	1C	1B	1A	100			
5	1B	1A	2C	100			
3	2C	2B	2A	100			
7	2B	2A	3C	100			
6	2A	3C	3B	50	50	50	100
8	3C	3B	3A	50	100		100
9	3B	3A	4C	50	50	50	100
12	3A	4C	4B	50	100		100
12	4C	4B	4A	50	100		100
11	4B	4A	5C	50	50	50	100
10	4A	5C	5B	50	50	50	100
10	5C	5B	5A	50	50	50	100
15	5B	5A	5A	50	50	50	100
13	5A-6C	5A-6C	6C	50	100		100
16	6B	6A	7C	50	100		100
17	6A	6A	7C	50		100	100
17	7A	7A	7A	50		100	100
14	7C	7B	7A	50	100		100
18	8C	8B	8A	50		100	100

TABLE III

EMERSON ELEMENTARY SCHOOL—1915–1916

CLASS No.	GRADES IN:				NUMBER OF HOURS CLASSES WERE SCHEDULED FOR VARIOUS SUBJECTS:									
	SEPT.	DEC.	"MID-TERM"	MAR.	NATURE STUDY	HELPERS	TEACHERS' ASSISTANTS	PHYSICS	CHEMISTRY	BOTANY	ZOOLOGY	SEWING	COOKING	SHOP WORK
4	2C–2B	2B–2A	2A–3C	2A–2B	200									
5	1C	1B	1A	1B–1C	200									
6	1A–1B	2C–1A	2B–2C	1A–2C	200									
7	2A–3C	3C–3B	3B–3A	3C–3B	200									
8	3C–5C	3B–5B	3A–5A	3A–4C		333⅓								
9	4	4	4	4		^{1}333⅓		33⅓		33⅓				
10				7C[a]										133⅓
11	5	5	5	5		^{2}333⅓		33⅓		33⅓				
12	6	6	6	6			66⅔		66⅔		66⅔		^{3}133⅓	^{3}133⅓
13	7	7	7	7			66⅔	66⅔		66⅔		^{4}133⅓		^{4}133⅓
14	8	8	8	8			66⅔		66⅔		66⅔		^{5}133⅓	^{5}133⅓
15	7	8	8	8			66⅔	66⅔		66⅔		^{6}133⅓		^{6}133⅓

(a) Class formed during the last term.

The same number at the upper left of the scheduled hours of two subjects indicates that the members of the particular class had a choice between these branches. In some cases the alternative subjects are not shown on this chart.

TABLE IV

FROEBEL ELEMENTARY SCHOOL—1915–1916

CLASS NO.	GRADES IN:			NUMBER OF HOURS CLASSES WERE SCHEDULED FOR VARIOUS SUBJECTS:									
	SEPT.	DEC.	MAR.	NATURE STUDY	HELPERS	TEACHERS' ASSISTANTS	PHYSICS	CHEMISTRY	BOTANY	ZOOLOGY	SEWING	COOKING	SHOP WORK
7	1C	1B	1B	100									
8	1B	1A	1A	100									
9	1B	2C	2C	100									
10	1B	1C	1C										
11	1A	1B	1B	100									
12	2C	1A	1A	100									
13	2C	2B	1A	100									
14	2C	2B	2C	100									
15	2C	2B	2B	100									
16	2B	3C	3C	100									
17	2B	3C	3B	100									
18	2A	2A	2A	100									
19	2A	3B	3A	100									
20	3C	3C	3B	100									
21	3C	3B	3A	100									

22	3B	4C	4C	100									
23	3A	3C	3C	100									
24	3A	4C	4B	100									
25	Mixed			100									
26	Mixed				200						^{1}200[a]		^{1}200
27	Mixed				200							^{2}200	^{2}200
28	4C	4B	4A	100	200						^{2}200		^{2}200
29	4B	4A	5C		300								
30	4A	5C	5C		200						^{1}200		^{1}200
31	5C	5C	5C		400								
32	Foreign	Mixed	4C		200						^{2}200		^{1}200
33	5C	5B	5A		200							^{2}200	^{2}200
34	Colored, 1st and 2d			100									
35	No class												
36	Colored, 3d and 4th												
37	5B	5B	5B	100		100			^{4}100		^{4}100	^{4}400	^{4}300
38	5A	5A	6C			100		^{5}100		^{5}100		^{3}100	^{3}100
39	6C	6C	6B			100			^{4}100		^{4}100	^{4}100	^{4}300
40	5A	6C	6B			100		^{5}100		^{5}100		^{3}100	^{3}100
41	6C	6C	6B			100	^{7}100		^{7}100		^{1}100		^{1}100
42	6C	6B	6A			100				^{9}100		^{9}100	^{2}200
43	7C	7B	7A			100	^{7}100		^{7}100		^{1}100		^{1}100
44	6A	7B	7A			100				^{9}100		^{9}100	^{2}200
45	8C	8B	8A			100	^{7}100		^{7}100		^{1}100		^{1}100
46	8C	8B	8A			100				^{9}100		^{9}100	^{2}200

(a) Part of the class spends this time in regular work.

The same number at the upper left of the scheduled hours of two subjects indicates that the members of the particular class had a choice between these branches. In some cases there was possibility of a choice of other subjects which are not shown on this chart.

signed to drawing, manual training, and household studies in those grades.

The figures above given differ considerably from the figures that appear on the school schedules. For instance, the Jefferson school schedule assigns to all classes either 50 or 100 hours of science work; the Emerson schedule assigns 200 hours to nature work in the first, second, and third grades; at the Froebel, the schedule runs from 100 to 400 hours. The differences in question doubtless arise in part from the fact that in certain grades time scheduled for science is employed for other purposes. It seems unlikely that all the time officially allotted to science was used for that subject in any of the schools. It also seems that the total allotted time represents, in the absence of any coherent plan of work, an excessive estimate of the time actually devoted to the work. The Emerson program, taken as a whole, schedules 2733⅓ hours possible for science for 11 classses; the Froebel, 5000 hours for 37 classes. Of the total Emerson amount, 1000 are listed for "helpers"; of the Froebel amount, 1900. "Helpers" are found mainly in classes devoted to science, sewing, cooking, and in the shops. The helper is a young pupil—in science usually belonging to the third, fourth, or fifth grade—who works side by side with older pupils on the theory that the younger pupil will profit by association and coöperation with the older. The educational outcome of the arrangement will be discussed later.

III. DAILY TEACHING SCHEDULES AND COMPOSITION OF CLASSES

SINCE the daily program of the teachers whose work is confined entirely to the primary grades is usually less complicated than that of the teachers of special sciences, the programs for these two groups of teachers are presented separately on pages 16–17. Also, although all teachers whose programs are here shown by special subjects teach both high school and grade classes, some of the teachers were unable to supply the desired data for all the terms of the school year and it must be borne in mind that these schedules are incomplete in a few instances.

In the Gary schools each class is assigned a number which bears no relation to the grading of the class. When, as appears in the column "Class Number," a class is said to consist of "12-11," an inspection of the next column shows that the grades of classes 12 and 11 are 6 and 5 respectively.

An inspection of the column "Scheduled Grade" shows that high school teachers who teach in the elementary school may have classes at any level in the grades. It is not intended that these teachers should teach pupils in primary grades except when there are too many primary classes for the primary nature study teacher and when vacant periods of other teachers may be temporarily occupied by teaching primary pupils.

TABLE V

FROEBEL NATURE STUDY DAILY SCHEDULE FOR PRIMARY GRADES

NATURE STUDY TEACHER IN PRIMARY GRADES	HOUR	CLASS NUMBER[1]	SCHEDULED GRADE	SUBJECT	TOTAL ENROLLMENT THIS TERM
Second Term	8:15	9	2C	Nat. Study and Gard'g	40
	9:15	21	3A	"	42
	10:15	12	1A	"	25
	12:15	11	1B	"	25
	1:15	28	4A	"	40
	2:15	8	1A	"	44
Third Term	8:15	7	1C	Nat. Study and Gard'g.	42
	9:15	5	1C	"	40
	11:15	34	Colored	"	24
	12:15	36	"	"	38
	1:15	25	Subnor.	"	25

[1] These class numbers should not be confused with gra denumbers. The Gary classes are assigned numbers independent of grading.

PARTIAL PROGRAM

	Hour	Class Number	Scheduled Grade
TEACHER OF CHEMISTRY			
First Term	10:15 11:15	38 38	5 5
Second Term	10:15 11:15	40 40	5 5
Third Term	10:15 11:15	30 32	5C Mixe sub- norm
TEACHER OF ZOOLOGY			
Second Term	10:15	40	5A
	11:15	32-40	5A mixe
	2:15 3:15	44 44	7B
Third Term	10:15	32	For' mixe
	11:15	30	4A
	2:15[1]	46-53	8-1
	2:15	54-28	12-
TEACHER OF PHYSICS			
First Term	8:15 9:15	40 40	5 5

PARTIAL PROGRAM OF S

		HOUR	CLASS NUMBER	SCHEDULED GRADE	
TEACHER OF CHEMISTRY					
First Term		10:15	16	8[4]	
		11:15	16	8[4]	
Second Term		10:15	12–11	6–5	5t 6t
		11:15	12–11	6–5	5t 6t
Third Term		10:15	14	8–6	6t 8t
		11:15	14	8	
TEACHER OF ZOOLOGY					
First Term		8:15	5	1C[6]	
		9:15	7	3[4]	
	(Girls)	10:15	16–1	8[4]	
	(Boys)	11:15	16–2	8[4]	
Second Term		8:15[1]	5	1	
		9:15[2]	7	3	3d 5t 6t
		10:15	12–1	6A	5t 6t
		11:15	12–2	6A	5 5 6t
Third Term		8:15	7	3	
		9:15		8[4]–2A	
	(Girls)	10:15	14–1	8	5t 8t
	(Boys)	11:15	14–2	8	8t 9t

TABLE VI

Emerson Nature Study Daily Schedule for Primary Grades[1]

Nature Study Teacher in Primary Grades	Hour	Class Number	Scheduled Grade	Subject	Total Enrollment the Term	Transferred	Dropped and Leaving School	Dropped and Remaining in School	Total in Class at Date of Reporting
Third Term	12:15	5	1C-1B	Nat. St.	72	22	4	5	41
	1:15	3	3B-3A	"	51	2	10	0	39
	2:15	4	2C-2B	"	60	18	6	1	35
	3:15	6	1B-1A	"	71	22	11	2	36

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[1] Since these classes included large numbers of pupils and since a good many pupils left school, were dropped or transferred, the data are added regarding the disposition of these pupils.

IV. NATURE STUDY AND GARDEN WORK IN PRIMARY GRADES[1]

SINCE there is wide variation between the kinds of work in nature study in the different schools, it is not possible to present all in a single statement. Therefore, a rather full statement is made for one school, following which the distinctive features of the other schools will be described.

A. THE JEFFERSON SCHOOL

A special room is provided for the work of science classes. It has been made by use of a partition and other structural changes in a room which was formerly an ordinary classroom. The rear portion of the room with south exposure has been separated for use as a plant growing house, animal house, and work place for the children for any work which requires the use of materials or processes which could not easily be handled in the main room. This room[2] is approximately 27 feet long and 8⅔ feet wide; that is, the room is as long as the main schoolroom is wide and is 8 feet 8 inches deep. This provides a growing house with three south windows, and one large west window. A long work bench runs along the south windows, and under this bench are earthen pots, animal cages, and other materials for class use. In the middle north wall are a wash basin and sink, provided with hot and cold water. Animal cages are placed about the room. At the time of inspection there were four cages with live animals, and also a number of empty cages. On one wall are racks for the hoes, rakes, sprayer, and other garden tools.

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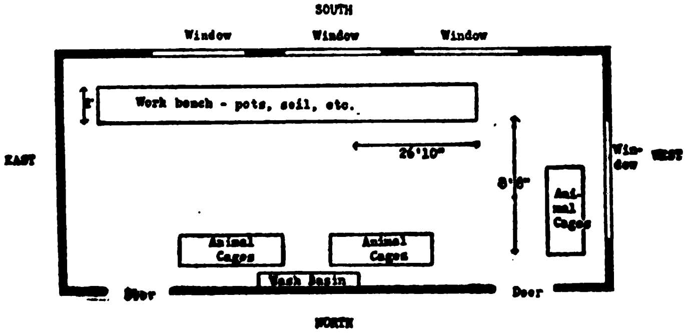
[1] Intermediate and upper grade work in the Jefferson school is included under this topic together with primary work.

[2] See illustration opposite page 8, and Figure 1, page 19.

The partition separating the nature study room from the main seating room is made of narrow wooden strips and glass so that there is the minimum of interference with the lighting of the room in which the children sit when at their desks. There is an additional advantage in that the children may easily look through this partition into the work room, and the teacher may easily see

FIGURE 1

DIAGRAM OF JEFFERSON NATURE STUDY ROOM



any pupils who are working in this room while she is with a class in the main room. The walls of the nature study room also have strong braces fastened to the window cases for the support of large flower pots in which there were specially fine plants, such as ferns and araucarian pines.[1]

The animal cages contained a guinea pig, a turtle, some rabbits and several white rats, some of which had young, which were of great interest to the children. The growing boxes contained small plants such as geraniums, chrysanthemums, wandering jew, which the pupils had started from slips, and which were to be used in the garden in the spring. There is a large garden visible from the windows of the work room immediately to the south of the school building.

The larger part of the room, while occupied by seats for the class, has additional features which are of value for nature study. Above the blackboard, molding runs around three sides of the room at such a height that maps, charts, pictures, drawings, mounted plant specimens and other children's handwork, collections of birds' nests, twigs of different kinds of trees, etc., may be placed in plain view of all children in the room. Much material of these kinds was kept constantly before the children; it was partially changed from time to time, as was evident on later visits. In the front of the room is a sand table on rollers, which can be easily moved from place to place.

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[1] See illustration opposite page 8.

B. BEVERIDGE SCHOOL

The nature study room in the Beveridge school is on the second floor of an old building, the first floor of which is used as the school auditorium. The room is provided with a wardrobe, a case for books, and a small corner room in which nature materials can be stored. There was a sand table on rollers, this table having been filled with soil and planted with growing plants. A long bench, 14 feet by 2 feet, had boxes upon it in which were seedlings that were being prepared for future garden work, toward which most of the nature study work of the school was directed. These boxes included seedlings of pansies, coreopsis, tomatoes, and cabbage. On one of the walls of the room was a wide cork wall board on which were displayed children's drawings of nature work and nature materials that were brought in by the teacher. A small aquarium with sunfish, and a small insect cage containing a Cecropia moth, three fern baskets hanging from the ceiling, a rabbit in the corner room, willows, dogwood, and twigs of other plants constituted the live material for study in the room. In a vacant lot at the side of the school building a garden space[1] is provided, this space being approximately thirty feet wide and eighty feet long.

C. THE EMERSON AND FROEBEL SCHOOLS

These schools include both elementary and high schools, and most of the nature or science work in the grades is done by the teachers who teach the sciences in the high schools. It is necessary, therefore, to present in this connection part of the grade work under the heading of nature study in the primary grades, and elsewhere to present part of the grade work under the headings of the special sciences.

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[1] See illustration opposite page 22.

These schools have abundant equipment in material for experimentation, in laboratory and shop space, in gardens, and in provision for keeping living plants and animals in and near the school rooms. The Emerson school possesses an extensive set of poultry houses, and a zoo in which are many kinds of native wild animals. The Froebel gardens include several acres,[1] and while the Emerson gardens are very much smaller, the Emerson school is provided with very much more equipment for animal studies than the Froebel school. The Emerson poultry houses[2] contain several kinds of domesticated fowls and pigeons, and the zoo contains wild ducks of several kinds, pheasants, foxes, raccoons, prairie dogs, opossums, skunks, coyotes, a wolf, a porcupine, and other animals. Both schools provide nesting boxes for wild birds, and both are located adjacent to extensive areas of undeveloped sandy land which are available for school use.

The details of equipment will appear more clearly in the later descriptions of types of work and in illustrations appearing therewith.

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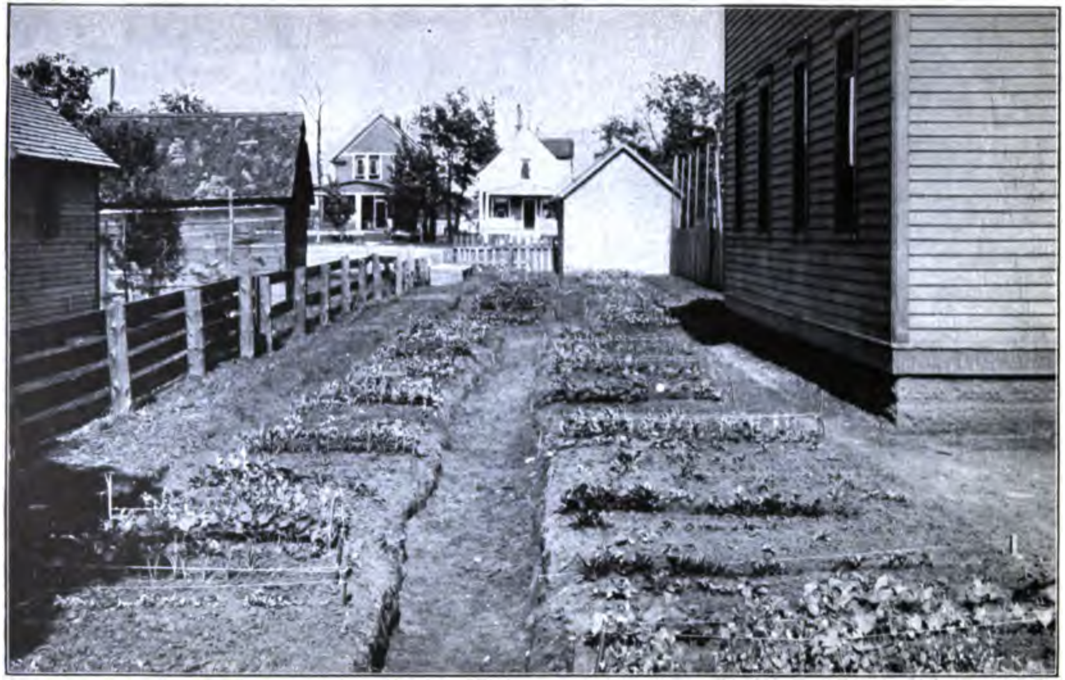
[1] See illustration opposite page 26.

[2] See illustration opposite page 34.



Elementary Garden—Beveridge School

D. OTHER SCHOOLS

The equipment in other schools—e. g., Glen Park and West Gary—was meager. At one time or another, however, these schools utilize for instructional purposes the striking features of the region in which they are located.[1]

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[1] See illustration opposite page 38.

V. STAFF AND INSTRUCTION IN NATURE STUDY

THE teachers of nature study in the Jefferson and Beveridge schools were graduates of Cornell University. At the Emerson and Froebel the work was also under the guidance of college trained teachers. The kindergarten and classroom teachers in the earliest grades give a small amount of the nature work.

Of general supervision there is almost none. That is, no member of the supervisory staff, not even the instructor in the Emerson school previously mentioned, coöperates with teachers in any regular way in planning their nature study work or in inspecting their classes from time to time. The teachers in the various schools meet but rarely to discuss their work. Within the several schools, the principals take a varying interest in the classroom work. At the Jefferson the principal's supervision was general, but helpful; elsewhere, it amounted to little. There was in consequence no unity of effort, as respects purpose, content, or method. Each teacher followed her own judgment and too frequently lived "from one day to the next." There was not only no course of study such as might afford general guidance to all who dealt with the subject—no complete course of study was procurable within any single school. Nor had any teacher kept a systematic record or diary of the subjects which had been taken up. On the walls and in the rooms was the only concrete evidence of the activities pursued, other than those which might be observed in operation at the times of visits. These were at times interesting and creditable. For example, the Jefferson school showed that the pupils in the preceding autumn had collected the seeds of the wild plants of the region and deserted birds' nests; they had mounted pictures of birds and other animals and made drawings of the landscape.

It is in consequence impossible to describe in general terms the nature study work of the Gary schools. At best, one can give examples of what was going on at the time of the survey. It may be assumed that similar activities of more or less unsystematic character were in progress at other times. At the Jefferson school, though garden work always occupies part of the time of grades doing nature study and though observational study of such objects as the pussy willow appears from time to time, for the most part nature study centered about geography. For example, a third grade class was engaged in studying the causes of winds. The recitation was typical of many observed. After a few general questions, the class was set to reading silently a text on the subject. After fifteen minutes, the same text was read orally, the teacher questioning the children on its meaning as they proceeded. From time to time the teacher endeavored to utilize the personal experience of the children in the matter of climate. Thus climatic differences between Florida and Colorado, between seashore and mountains, were made vivid. In connection with winds a home experiment on the action of heated air was suggested, though unfortunately "cold fairies" were also mentioned by the teacher as possible causes. Finally, a spelling lesson was made of the unusual words occurring in the text read. In much the same fashion, a seventh grade class went through a lesson on the rotation of the earth. Though the reading matter assigned was difficult, the questioning was excellently carried out.

At the Beveridge school, the teacher, who had only recently entered the Gary service, selected from day to day such topics as in her own words seemed "to fit in best." Her plan book showed for one class a succession of lessons dealing with seeds, pussy willow stories, a field trip for branches, the transplanting of seedlings; for another, a field trip for willows, a lesson on sparrows, a lesson on robins. In the main, however, her work was connected with the garden. In management it did not differ materially from the lesson above described. For instance, a class studying the dry bean first observed the object, followed the teacher's exposition and drawing of its characteristics, read silently an account in a convenient text, and then returned to the object. Finally, the common words employed were used as a spelling lesson. Subsequent visits to the school in the course of the spring found the children working in the garden effectively and with a fair amount of intelligent oversight. In general, the teacher—and in a measure this is true in other schools also—being left without central guidance, having therefore to work out everything independently, and having a long teaching day, had neither time nor energy to prepare a coherent course or to secure and prepare the materials which the work required.

The work offered in these schools differs only in respect to variety. The kindergarten children of the Emerson school, for example, care for hens of different kinds and study the differences in their eggs and in their young; they own a turtle, rabbits, and gold fish, of which they have charge. The topics selected for study were, however, of the kinds already described and the work was similarly conducted. At the Froebel, lessons were in progress dealing with poison ivy, the peanut, points of the compass, etc. Noticeable on one occasion was the presence of three "helpers," who remained in the room throughout the entire hour with nothing to do and with no opportunity for coöperation. Once when one of the helpers became restless, the teacher turned to her with the words: "Real helpers must not disturb. Please be quiet." The order was obeyed.

A third grade class at the Emerson is described by its teacher as having pursued the following program, giving to it one hour daily, five days weekly, for forty weeks:

> The time was divided into four periods. In these periods were studied: first, the earth, or geography; second, the plant world; third, the animal world; and fourth, nature stories. In the first section of the year

the children talked and learned of Gary, the city in which they live; of Lake County, the county in which their city is located; of Indiana, the state in which they live; of the United States as the country in which they live, and North America as the continent of which the United States is a part. These topics were covered briefly, and the points emphasized were those with which the children were somewhat familiar and in which their experience led them to be interested. Plant life was studied even more briefly because of the probability that these children would go to the botany class for such studies in the next year.

In the study of animal life the children chose the animals in the school's collection which most interested them, the coyotes, raccoon, prairie dog, gray wolf, porcupine, skunk, rabbit, hares, etc. The topics included inquiry as to where these animals are found in their natural state, what they eat, whether they are harmful or harmless, and what use is made of them in the commercial world. When the class had finished the list of animals in the school's zoo, they were allowed to choose any other animal about which they wanted to learn.

In the spring a small amount of work was done in the identification of birds, with the result that the pupils as a class learned the names of 53 birds.

During a part of the year post card nature study pictures were given the children and stories were written about the animals in the picture. Most of the children in the class learned the names of the cocoons in the collection in the room, could distinguish one from the other, and were able to identify the moths when they emerged. They also learned the difference between a moth and a butterfly. In helping to keep the large aquarium clean they learned of algal forms and examined a few of them under the microscope.

In the nature study stories, attempt was made to choose the stories with care so that the ideas given in the story would be true to the facts of natural history and awaken in the minds of the children not only an interest in, but appreciation of, animals.

The foregoing was one of the few outlines which the author was able to procure.

VI. BOTANY AND GARDENING

(A) FROEBEL SCHOOL

THE Froebel school equipment for botany and gardening includes an excellent laboratory[1] in which there is equipment, such as aquaria, laboratory materials of the usual kinds, a few microscopes, seed collections, garden magazines and seed catalogues. One large room is used for indoor laboratory work, recitation and conferences, reading room, and individual work room for any botany pupil who is engaged in work upon a project. This combination of various interests centered about a particular science study in high schools is to be strongly commended as a great improvement upon the too common plan of separation into "Laboratory" and "Class Room" or, still worse, "Lecture Room." The room is a work room or shop in which pupils and teacher conduct experiments, discuss, read, report, or write records, and is immensely preferable to the differentiated and technically scholastic high school practice of having recitation or lecture in one room, laboratory in another, reading in a third room, and too often no very real problems to solve in any one of these rooms. The botany work room in the Froebel school and the other science rooms at Gary are planned to centralize and focus interest upon the problems to be met. The Froebel teacher of botany has, as will be seen in a later statement, developed the work so as to centralize about the garden all the botany work within doors and out of doors. Indeed the garden is the dominant center of all the work and the botany room quite properly is little more than a means of carrying on those aspects of the work which cannot be conducted out of doors.

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[1] See illustration opposite page 44.

The school garden consists of several acres, the whole area including 16 acres. At the time of inspection of the school work, there were approximately 300 gardens in use, and this number could be increased by subdivision of the gardens as needed.

(B) EMERSON SCHOOL

The Emerson school is provided with a small school garden and a school ground of several acres upon which considerable shrubbery is planted. In the school building there is provision made for growing plants indoors by the use of the windows at the stair landings as greenhouses, by the use of a section of the botany laboratory, and by the use of the hallways. In the laboratory there is the usual equipment of aquaria, tables, microscopes, etc., not differing from the equipment of ordinary laboratories sufficiently to justify further description. The school makes a commendable use of a single room for laboratory, demonstration, recitation, and study, thus making all the indoor material available at any time.

The garden work of the other schools is mentioned in connection with the discussion of work in nature study.

In the botany work of the Froebel elementary school, no effort is made to follow any of the ordinarily accepted grade courses of study. In the high school course, while a regular text is used as source of reading material, extensive readjustments are made in order and in content. In the grade garden work the teacher makes excellent use of out-of-door experiences and classroom study by organizing these into definite topics, often projects. A coherent sequence of topics or projects is not regarded as essential, but vitality of each topic or project is entirely essential to the plan pursued. The time allowed for the grade work in the Froebel school is one hour daily.

The following statement of work done by the sixth grade class may be taken as fairly representative of the work in this school:

PROJECT—HARVESTING

The work of this grade (6C boys and girls) consists largely of garden work with just as much of the science of botany thrown into the scheme as will help in understanding the different situations. In the "harvest scheme" there are included those things which pertain to gathering of material from the garden which could have any possible immediate or future use. The work is grouped into the following divisions:

1. Gathering and disposing of all (edible) crops
    For home use from individual gardens
    For domestic science use
    For sale
    For storage for winter
2. Selection, collection, cleaning, labeling and preservation of fruits and seeds (both flowers and vegetables) for use in the school gardens the following year

3. Transplanting for schoolrooms and for conservatory use
4. Gathering and storing tender perennials (gladioli, dahlias, etc.)

In addition to the garden work, there are occasional field trips, in which underground parts, and fruits and seeds were especially studied; also occasional periods were used in the Froebel Park where the time was spent in such practical work as tillage, spraying, etc.

In gathering vegetables and in transplanting, etc., the children come in contact not only with a large number of kinds of plants but they also come in contact with various kinds of underground parts, and come to know them and distinguish them rather easily. Such underground parts are:

1. Soil roots—Tap-roots
    - carrot, lettuce
    - cabbage, parsley

   Clustered dahlia

   Fibrous
    - onions
    - potato
    - tomato
2. Tubers—Potatoes, and Mexican potatoes which also have aërial tubers
3. Bulbs—Onions; Lilies
4. Corms—Caladium, Gladiolus
5. Rootstocks—Canna, Ferns

This class also had an opportunity to plant a large bed of bulbs and corms—hyacinths, tulips, daffodils, Bermuda lilies and crocuses.

In collecting their seeds, over ninety different species were collected, labeled, and preserved. The pupils had an excellent opportunity of studying the various problems connected with fruits and seed; such as:

a. Seed selection
b. Variation
c. Cleaning, drying and preserving for winter
d. Seed distribution
e. Germination of self-sown seeds of lettuce, hollyhocks, etc.
f. Origin of fruits and seeds
g. Pollination and fertilization
h. Edible and non-edible fruits
i. Structure of seed including:
    Food storage,
    Seed-coats, and embryo.

In connection with the above outline of work such topics as the following were considered: climbing and procumbent plants; annuals, biennials, biannuals, and perennials; deciduous and evergreen; plant diseases, insecticides and fungicides; kinds of food stored and where.

The teacher used the garden work as the basis of auditorium programs to be given before other members of the school. For example, a group of sixth grade boys presented their work under the heading "Interesting Commercial Plants." They presented discussions of tobacco, pop-corn, peanuts, flax, castor bean, cotton, and clover. A group of sixth grade girls presented "Seed Distribution" and used wild and cultivated plants, drawings, and demonstration experiments. Another group of fifth grade girls presented a "Thanksgiving Harvest Play" as an auditorium exercise. In addition to the plant studies used in this play, they studied and presented some of the harvest time customs of ancient Greece and Rome and early America.

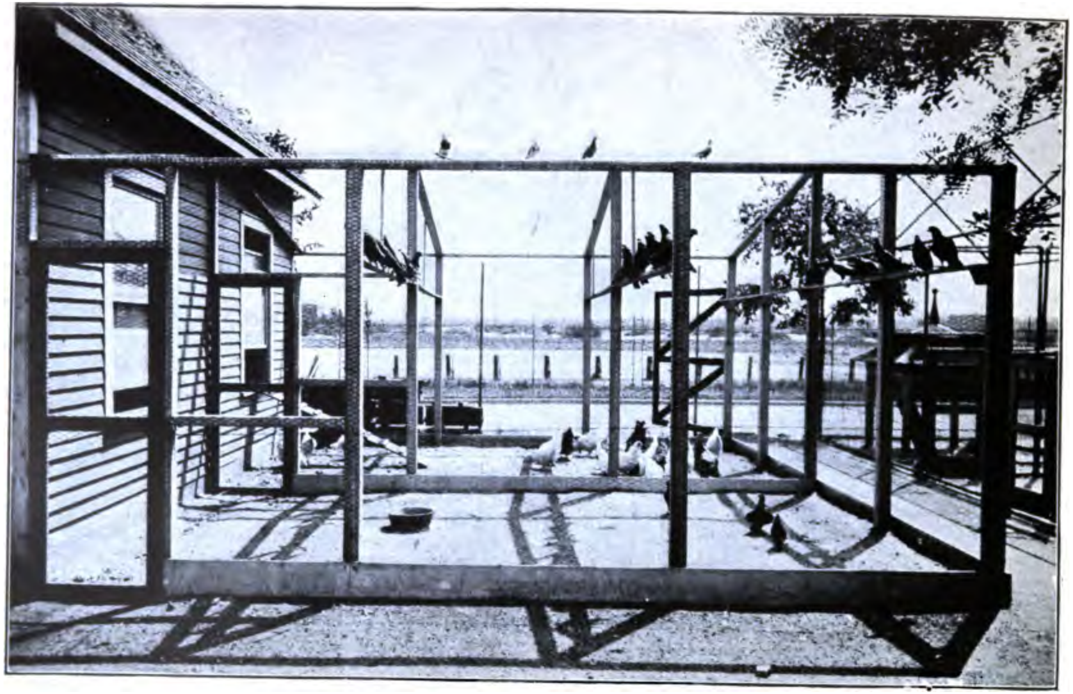
An auditorium science program of this type is said to require for preparation an average of approximately two weeks of the scheduled science time. This expenditure of time can be justified on the ground that the auditorium supplies a strong motive for rounding up the work done, and gives training in presentation of a subject to others.

The following is a list of the projects which appear in the teacher's outline of work for the botany and gardening course:

Harvesting
Preparation of Gardens and Shrubs for the Winter
Fall Clean-up of Grounds and Home Lots
Preparation for Spring Gardens—part of which focused in an Arbor Day Program
Study of the Lower Plant Forms of the Vicinity
How to Raise the Best Fruits and Vegetables from Individual Plots
Preparation of Seed Bed
Garden Diagrams
Soils
Study of the Struggle for Existence among Plants
Study of Seed Dispersal
Study of Plant Distribution in the Region of the School
Meaning of Photosynthesis
Relation of Plants to Water
Types of Flowering Plants for Home Use

Of the course above outlined it may be said that it can be readily adjusted to meet the needs of pupils of different ages. This was the more essential because classes not infrequently contained pupils some of whom had already studied the subject, while others were just beginning it, and still others who gave different amounts of time to the work, as well as assistants and helpers.

At the Emerson school the course in botany is taken primarily by seventh and eighth grade pupils. Different divisions of the seventh grade are taught together as one class; i.e., 7A's, 7B's, and 7C's are combined. The seventh grade work is based primarily upon the care of the garden, the shrubbery on the school grounds, and the potted plants which are kept in the schoolroom greenhouse and in the hallways of the school building. The high school course, which is provided for pupils in the



Poultry Houses—Emerson School

ninth grade, is based upon the outline of work which appears in a course called "Practical Botany." The textbook is followed quite closely, the laboratory and demonstration work being of a conventional nature designed to illustrate the points discussed in the text. The course which is given to the seventh grade runs throughout the year and is recorded as having a full hour each day five times a week for that period. Observations led to the conclusion that this schedule was not followed regularly since there was evidence that pupils sometimes were engaged less than the full hour, sometimes about half an hour, and sometimes less than five days per week. In some cases the pupils had a half hour with the botany teacher and a half hour with the physics teacher.

The following comprehensive outline of seventh and eighth grade courses was supplied by the teacher. It was explained by the teacher that no class covered all the topics in the outline.

OUTLINE OF BOTANY COURSE FOR SEVENTH GRADE OR EIGHTH GRADE PUPILS

I. SOIL

Top soil
Sub soil

A. Agents in soil formation
    a. Heat
    b. Cold
    c. Water
    d. Frost
    e. Ice
    f. Plants
    g. Animals

B. Kinds of soil
    a. Clay
    b. Sand
    c. Humus

Samples—Comparative value and characteristics of each

C. Physical properties
  - a. Mellow
  - b. Fine
  - c. Loose
  - d. Porous
  - e. Hard
  - f. Cloddy
  - g. Compact
  - h. Sour and sweet

  Samples—Characteristics of each. How characteristics are acquired or prevented

D. Chemical properties
  - a. Carbon dioxide
  - b. Water
  - c. Oxygen
  - d. Nitrogen
  - e. Phosphorus
  - f. Potassium
  - g. Calcium

  Value of each; characteristics.

  How soil gets each naturally; how each may be supplied artificially.

E. Weather on soil
  - a. Rainfall. Observations in amount. Effect on sand, loam and clay
  - b. Sunshine. Daily observations made on the effect of variation. (Garden and conservatory)

  Daily weather record kept during garden season

F. Water in soil

  Forms of water
    - a. Vapor
    - b. Free water
    - c. Film water

  Experiment and drawing to show capillarity.

  Importance

  Sources

  Retention

  Drainage: value, means, benefits, methods; open drains, tile drains. Experiment to show effect of drainage.

G. Tillage of soil
  - a. Value
  - b. Method
  - c. Tools used—How constructed, how used, when used.

H. Fertilization of soil
  - a. Advantage
  - b. Kinds of fertilizer
    - 1. Manure
    - 2. Commercial; its ingredients. Specimens.
    - 3. Root tubercles; specimens; importance.

Written work on the above subjects.

Dead and living matter. Examination of grain of sand and a cell of the yeast plant.

II. PARTS OF THE PLANT

A. Roots
  a. Kinds of roots
    1. Air roots
    2. Water roots
    3. Earth roots: tap roots, fibrous roots, root hairs.
  b. Work of roots
    1. Absorb: water, oxygen, other food materials.
    2. Anchor
    3. Store food
    4. Reproduce
  c. Depths to which they grow—reasons.

Specimens of each of the above for drawing.

  d. How roots secure food material
    1. Experiment to show osmosis
    2. Experiment to show that plants contain mineral matter

Drawings and description of the above.

B. Stem
  a. Epidermis
  b. Bark
  c. Wood: up current, down current; diagram showing relative position of each.
  d. Pith; danger of a girdle.
  e. Annual rings; specimens.
  f. Hold leaves to light.

C. Leaves
  a. Parts: petiole, blade.
  b. Covering
  c. Leaf green—use and specimens
  d. Work—sunlight helps to make food. Starves plants by putting them in dark. Tests for starch.
  e. Breathe; experiment.
  f. Throw off water; experiment.
  g. Shape and margins.

h. Arrangement on stem—opposite, alternate, whorled. Specimens. Written descriptions and drawings of the above.

D. Flower—definition
  a. Use
  b. Parts; uses of parts, specimens to show how these vary.
  c. Pollination
    1. Natural pollination
    2. Hand pollination
    3. Self pollination
    4. Cross pollination
    5. One household
    6. Two households (willow)
    7. Staminate
    8. Pistillate (Begonias)
  d. Fertilization
    Hybrids

Description and drawing of several typical flowers.

E. Bud—definition
  a. Classes
    1. What they produce: leaves, flowers, both.
    2. Position: outside axis, irregular in axis.

III. REPRODUCTION OF PLANTS

A. Seeds
  a. Definition
  b. Parts of the seed and uses of the parts. Seeds sprouted in garden or conservatory. Difference between bean and corn (in seed and stem).
  c. Conditions necessary for germination. Experiments.
    1. Heat, 2. Air, 3. Moisture.
  d. How seeds are tested. Experiments.
    1. Purity
    2. Vitality (Specimens of both sorts are planted).
  e. Planting seeds (garden and conservatory).
    Manner: rows, hills, broadcast.
    Depth. (Garden experience)
  f. Seed dispersal
    1. Advantage
    2. Means: wind, water, animals, man.
    3. Examples

B. By bulbs. (Secure about 300 bulbs and force for winter flowers.)

C. Cuttings. From geraniums grown in garden, carnations, roses, etc.

Elementary Garden—West Gary School

D. Budding: Advantages. Method. Irish potatoes in garden. Experiments.

E. Grafting: Advantages. Method—making wax, root grafting, tongue grafting, cleft grafting. Experiments.

F. Leaves. Begonia as example. Pruning: How done, why, how seedlings are raised. Experience in grounds. Written description and drawings.

IV. DANGEROUS PLANTS

A. Definition of a weed
  a. Why dangerous?
  b. Specimens to be secured: ragweeds, cockleburs, dandelion, wild mustard, sorrel, jimson, pig weeds, plantain, poison ivy, tumble weed, burdock, Russian thistle, wild-buckwheat.

B. Plant diseases: corn smut, apple rot, lemon mold, bread mold, potato blight, club rot, lilac mildew, "pod spots" beans. Specimens of each. Causes, prevention, cure. Consult government bulletins.

V. GARDEN

A. Prepare and plant the hot bed.
B. Clear garden of refuse.
C. Examination of old tools and orders for new.
D. Spade and rake. Each child takes turn.
E. Measure. Plot with view to utility, beauty and convenience. Set stakes. (Each child makes a plot on paper.)
F. See that crops are rotated; reason.
G. Decide what we wish to cultivate; selection of seeds from catalog; orders for seeds made by pupils.
H. Various seed beds prepared.
I. Methods of planting various seeds.
J. Records to show time necessary for different seeds to sprout.
K. How different crops are cultivated.
L. Transplant. Cabbage, tomatoes, cauliflowers, cosmos, egg plant, pepper, etc.
M. Careful weeding and reasons.
N. Records of rainfall and effect.
O. Comparative rapidity of growth of vegetables.

P. Harvest and prepare vegetables for sale.
Q. Hand pollination.
R. Collect seeds and label.
S. Make window boxes for building.
T. Transplant the plants for building.
U. Care of shrubbery: cultivate, prune, water.
V. Care of lawn: re-seed, mow, clip, rake.
W. Care of trees: prune, water, health.

VI. FARM CROPS

A. Forage crops: grasses, alfalfa, clover, millet, timothy.
How a silo is built and filled.
B. Cereal crops: corn, wheat, rice, barley, rye, oats.
C. Fiber crops: cotton.
D. Root crops: potato.
E. Beverage crops: coffee, tea, cacao.
F. Spices: pepper, ginger, cloves, nutmeg, cinnamon.
G. Sugar crops: sugar cane, beets.
H. Tobacco.
I. Rubber.

Where the above crops are best cultivated; how cultivated; how harvested. Uses.

Maps drawn to show localities where they grow.

Specimens and pictures of all plants and their products.

Excursions to neighboring woods, city parks, Gary parks, Gary market, school farm, Gary greenhouses, Gary nursery.

A single day's eighth grade exercise may be described in order to illustrate the regular outdoor work. Some pupils were engaged in pruning shrubbery, others in hoeing and raking the soil about the plants, which were both shrubs and annual flowering plants; some were watering plants, some were watering the house plants within the building, pulling off dead leaves, and pruning away broken portions. It was stated that no employed workman assists in caring for these plants, all the work being done by the eighth grade botany students, under supervision of the teacher of botany. The garden work is also done by this class. They not only give the ordinary care to planting, cultivating and harvesting the crops, but do the heavy work of wheeling or carting manures, spading, and construction of cold frames or other structures that are needed in the garden. The pupils engaged in these activities evidently took great pleasure in their work. Indoor related work includes such topics as the care and improvement of soils, proper selection of garden and farm seeds, preparation of and practice with spelling lists containing names of plants, processes, or implements. Occasional field trips are made to adjacent regions, but these must have been rare and brief since the pupils have but one hour available each day for this work. No single textbook is used but numerous books are made available so that pupils may learn the proper care of plants in lawn, garden, and schoolroom.

The ninth grade course, which is based upon one of the common texts in botany, does not follow the order of presentation in the text—a commendable variation. Local considerations should largely decide as to the order and nature of materials presented. Very properly, too, no effort was made to handle separately recitation, class discussion, and laboratory work. The work in hand was carried on by one method or another or by all, as circumstances suggested. On the other hand, there was evidence that this particular ninth grade class did little work out of doors. The microscopic work and the drawings about the hallways—enlarged as they were from textbook plates—appeared to be of slight educational value.

VII. ZOOLOGY

(A) EMERSON SCHOOL EQUIPMENT

FOR instruction in zoology, the Emerson school is equipped with an excellent combination laboratory and recitation room which includes aquaria in abundance for work with aquatic animals. There is also a large room in the building for various kinds of animals, which are cared for by the elementary and high school pupils. This room is equipped with a large coop for poultry, containing pigeons and chickens, and cages for such animals as the porcupine and rabbits. Another room is occupied by incubators, of which three are provided for poultry work managed by the department of zoology. Out of doors there is extensive equipment for the care of animals, including a poultry house, incubators and brooding house, a pigeon house, large cages for quadrupeds, such as the wolf, coyote, fox, raccoon, porcupine, prairie dogs, large cages for a number of kinds of wild duck, and pens for runways for various kinds of poultry. At the time of the survey the live poultry included a pen of 26 white leghorn hens, 42 Rhode Island red hens, several dozens of carneaux pigeons, several kinds of wild ducks, and several kinds of pheasants. There is a small barn in which the horses and implements used by the school are kept. This department is the best equipped science department in the Gary schools.

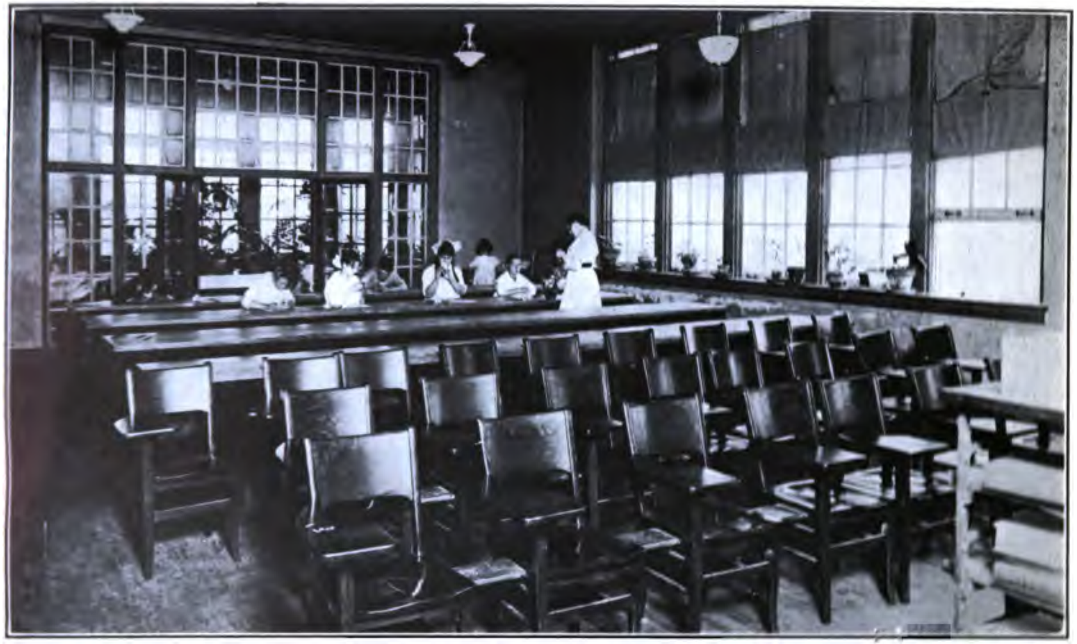
(B) FROEBEL SCHOOL EQUIPMENT

In the Froebel school the equipment for the department of zoology consists of a good laboratory-recitation room, in which there are aquaria, making it possible to keep various kinds of living animals. There is no collection of animals and no poultry yard or other equipment comparable with those of the Emerson school.

(C) THE EMERSON COURSE IN ZOOLOGY

The entire department of zoology at the Emerson school was in charge of a well trained and effective instructor assisted by a trained assistant in poultry husbandry and a workman who looked after the horses and the barn, etc. The class studying the subject of zoology was composed in the main of high school pupils from the tenth, eleventh, and twelfth grades. The course ran for 40 weeks and occupied two hours a day, five days weekly. The time was so divided that two months were given to the study of insects in the autumn, three or four months to the study of the main animal groups, a month or six weeks to physiology, and the rest of the year to the study of materials collected from the environment. Individual projects were largely employed and elaborately developed.

The instruction in zoology was in the main related to various types of animal activities. It is not possible to furnish a complete account of the topics touched on in



Botanical Laboratory—Froebel School

the course of the year, but the way in which a topic is handled is indicated by the treatment of insects. The grasshopper, June bug, and Cecropia moth were used as types of insect structure. The class did laboratory work with these forms, including discussions and detailed drawings. The text used for this part of the work treats such topics as "Insects and Plants," "Insects and Human Disease," "Insect Enemies of Live Stock," "Beneficial Insects," "Household Insects," "Human Parasites," and "Insect Control." Since Gary is often infested in the summer by mosquitoes in large numbers, the class made a detailed study of mosquitoes and outlined methods for ridding the community of these pests. Field trips were conducted so that the pupils might determine the number and kinds of places in which mosquitoes develop, and collect specimens for laboratory use. Field trips were also conducted for the collection of cocoons of various kinds of moths, and these were cared for in the laboratory. Also caterpillars were collected and kept in the laboratory until they made their cocoons.

It has been stated that much of the work in zoology takes the form of individual projects. This is especially true of work with pets and fowls. For example, the care of the pigeons and squabs in the animal house was assigned to two girls; a boy looked after a group of wild ducks and tried to grow the young wild ducks in captivity; three girls were assigned to the care of the animal room in the school building, each having her own time and responsibilities connected with the work. One girl had charge of a pen of golden pheasants, another of the silver pheasants, and still another of the ring pheasants. In order to secure time for their projects, individual programs were so arranged as to allow a one hour period daily for the work.

In the autumn of 1915 an ambitious project in poultry work was undertaken in the Emerson school. It began with thirty chickens. During the fall pupils cleaned and disinfected the animal cages, kept the lot clean, mixed feeds for the poultry, and cared for them in various ways. The pupils also built a concrete foundation and a floor 14 x 14 feet for the poultry house, and assisted in the construction of a cement room in which it was proposed to carry on the incubation and breeding of young poultry. When out-of-door work was impossible, there was blackboard drill in the study of feeds, housing, etc. Diagrams were made by the pupils to show how to construct feeding boxes and brooding houses. Pupils of all ages from the third to the tenth grade participated in these activities.

A period of 13 weeks was devoted to the special problem of fattening selected chickens for the market. The construction of a special fattening crate became necessary; plans were drawn roughly on a blackboard and discussed, and the crate was ultimately constructed by the pupils themselves in the carpentry shop. As more time was required than could be given on the regular school schedule, several pupils came after school hours, even at night, to work on the crates.

The pupils bought the chickens, weighed them, and placed them in the fattening crate, and kept records of their progress.

The table on page 48 and the chart on page 48a are fair samples of the records kept.

Unfortunately, the pupils were left so largely to their own devices, that errors were frequent. Pupils were thus misled as to the results obtained, and the incidental benefit expected from the vitalization of work in mathematics was lost. On the other hand, the work was interesting in itself and gave the pupils both information and skill that are of great value.

The incubators were also handled as projects by successive groups of three pupils in charge for periods of three weeks each. The boys gave to the work one period daily of school time and such time after school as was required. Responsibility was so divided that one boy regulated the heat, while the others watched the eggs. Egg testing with a view to the elimination of infertile eggs was carried on in the presence of the rest of the class.

The number of children responsibly engaged in poultry projects at any one time obviously cannot be large. On the other hand, at the time of the survey, 72 children were counted about the poultry yards in the course of a single day. Most of them appeared to have no definite task; yet their interest, as manifested in questions, was both wholesome and helpful, and absence of definite assignment is therefore not necessarily evidence of absence of important educational values.

TABLE IX

POULTRY FATTENING

16 BIRDS. STOCK, COMMON "SCRUB" FALL CHICKENS

DAY	TIME	TEMP.	WEIGHED IN	WEIGHED BACK	FEED CONSUMED	REMARKS
			PERIOD I			
		DEGREES	OUNCES		OUNCES	
Dec. 4	8:40	70	64	24	40	Milk fed sweet.
Dec. 5	8:40	65	72	8	64	Condition good.
Dec. 5	4:00	70	56	0	56	Birds eager for feed.
Dec. 6	8:10	70	72	6	66	Weather fair.
Dec. 6	4:20	72	134	43	91	
Dec. 7	7:55	68	91	27	64	
Dec. 7	4:25	62	91	12	79	Colder.
Dec. 8	7:55	50	79	0	79	
Dec. 8	4:25	68	83	3	80	
Average temperature, 64 degrees[2] Average feed consumed, 66½ ounces[3]					662[1]	

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[1], [2], [3], Errors in calculation, uncorrected as shown here, appeared in each of the pupil-made records which were submitted for inspection.

INCUBATOR RECORD

CYPHERS MACHINE

HATCH STARTED 8 A. M. THURSDAY, APRIL 13, 1916.

266 EGGS

STOCK - WHITE PLYMOUTH ROCKS

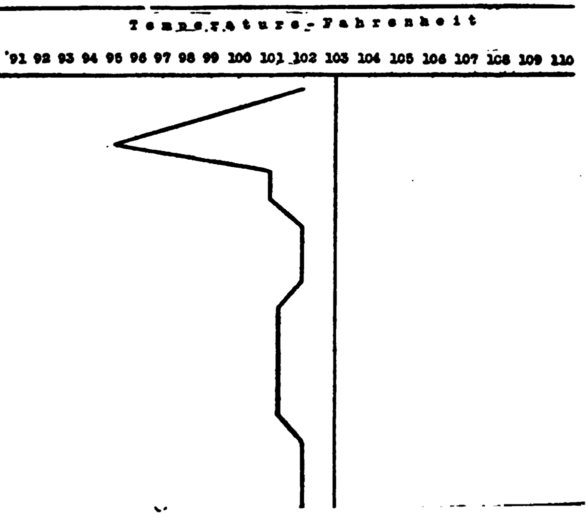
INFERTILE 4/20 58

DEAD GERMS 4/28 18

HATCH 30 dead in shell
3 cripples
157 sound chicks

Lawrence Tittle and James Alison

	Date April	Hr.	Room Temp. F.	Oil Consumed Ounces
	13	8:15	72	5-9
		12:00	70	4-10
		5:00	70	0-15
1	14	8:15	67	5-5
		1:15	68	
		4:00	68	
2	15	9:15	70	1-5
		1:30	70	3-14
		5:00	70	
3	16	11:00	68	5-3
		6:00	67	
4	17	8:00	69	1-1
		1:15	72	
		5:00	68	
5	18	8:15	69	1-0
		4:15	69	



In addition to the tabulated records already presented, pupils working on projects in zoology are obliged to submit a written report of their work. The following is an example:

POULTRY FATTENING

Part of our poultry work has been the study of milk fattening. This kind of fattening makes the flesh of the birds sweeter, whiter and tenderer so that it cooks very much easier. We have a special ration for feeding the birds which consists of butter milk 8 parts, corn meal two parts, ground oats 1 part, and shorts 1 part.

We boys went down to Tittle Brothers Store on Fifteenth and Broadway and bought sixteen spring chickens. We then brought them over to school and put them in a fattening crate which was 4 feet long and 3 feet wide. It was made of slats with a wire bottom and with troughs along in front for the feed. The crate is divided into two compartments, each compartment holding 8 birds.

We put a leg band on the right leg of each chicken to tell them apart and to tell which one of them gained the most during the period of fattening which was two weeks.

The boys divided the time into three periods. James Allison had the first period, I had the second period, and Lawrence Tittle had the third period. We fed the birds every morning at 7:30 and every evening at 4:30. The feed had to be mixed and let stand for twelve hours before using. We let the birds eat for 30 min. and then what was left we weighed back and added it to next days feed. Here is a chart showing the different gains and feed consumed in the three periods.

	FEED CONSUMED[1]	GAIN
Period I	662 oz.	166 oz.
Period II	590 oz.	26 oz.
Period III	752 oz.	26 oz.
Total	2,004 oz.	218 oz.
Average per bird .	125¼ oz.	13⅝ oz.

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[1] The reader is referred to page 47 for statements regarding the accuracy of these computations.

Here we note that in the first period we had the most gain and in the last period we had most feed consumed and very little gain. This proves that it pays to feed only about one week as the last two periods the birds did not gain enough to pay for their feed.

We kept a table telling time of day, temperature, the weigh-in for feeding, the weigh-back after feeding, the feed consumed, and any remarks.

We let the birds fast twenty-four hours before killing. On Saturday morning we came over to school and with the assistance of Mr. Stewart we killed and dressed the chickens. They were weighed after they were killed, after they were picked, and after they were drawn. Then we let them lie in salt water for about an hour and then we wrapped them and delivered them to homes where they had been ordered. The birds sold for from 75 to 90 cents. All three of us boys liked the work very much and we were all up helping each other every morning and evening during the three periods. And I can say myself that I would a hundred times rather eat milk chicken than I would the ordinary grain fed ones.

A pigeon project is thus described by the two girls who were responsible for it:

About March 1st, we two girls, who are students of the Emerson Zoology Department took charge of the pigeons belonging to the School. These pigeons are French or Carneaux pigeons. They have beautiful brownish red plumage. They are of good size and we have about 30 of them. When we took charge of the pigeon house there were no nests in it. After reading all available material on the subject of pigeon raising, we began at once to put the house in good condition for them. We first had it cleaned. Then we put nest divisions in the boxes. There are about thirty nest boxes in the room, fifteen on each side. The first row is about four feet from the floor. The boxes are about one and one-half feet square. The divisions are boards which cut the boxes into equal compartments. The board runs down the center and one closes the front of the nest box. These boards are about 5 inches in height. We next obtained tobacco stems and broke them into pieces. The pigeons made their nests of these. The tobacco stems help to keep the nests free from vermin.

We have been feeding them barley in the hopper each day, with a dainty of Canadian peas and Kaffir corn every other day. Rock salt is kept on the window of the house as pigeons seem to require salt in order to remain in good condition. They seem to be doing well on this line of food.

There is a fly pen adjoining the house which is about eight feet by ten feet. In this there is a bath pen which is cleaned and filled with fresh water daily. The fly pen gives the birds a good place for exercise and for sunning themselves.

The breeding season is now here and up to this time we have eight squabs which seem to be growing large and fine. There is a man in Chicago who furnishes the Blackstone Hotel their full supply of squabs. Chances like this are not hard to find if one can guarantee a supply. A great many hotels, boarding places, hospitals and sanitariums give yearly contracts for squabs and pay good prices. There is much profit in squab raising and the work is not hard. We would advise any one to take up this work if the opportunity offers, for we have derived much pleasure from it in the short time we have been working at it.

VIII. PHYSICS

THE physics laboratory of the Emerson school, used by both elementary and high school pupils, includes a combination laboratory and recitation room, a shop room,[1] and a storage room. While some of the ordinary pieces of physical apparatus were found, most of the equipment consisted of extremely simple apparatus such as is met in everyday experience, and of machines of various kinds which illustrate physical principles. Discarded machinery—such as weighing devices, photographic cameras, a sewing machine, an automobile engine, automobile bodies and bicycles—were collected in the shop for the use of students of physics. The whole department had the appearance of an ordinary shop rather than that of a physics laboratory. The equipment could be used without danger of serious damage or heavy financial loss.

The equipment of the Froebel school laboratory was less noteworthy.[2] In addition to ordinary school apparatus, it contained a small number of appliances derived from the activities of the environment.

At the time of the survey, instruction in physics in the Emerson school was given to two fourth grade classes, a fifth grade class and a high school class in which two high school grades were combined. It was shown by inquiries in other studies that there were pupils in the upper high school class who had not studied the subject. These may have been pupils who had entered the Gary schools from other school systems.

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[1] See illustration opposite page 54.

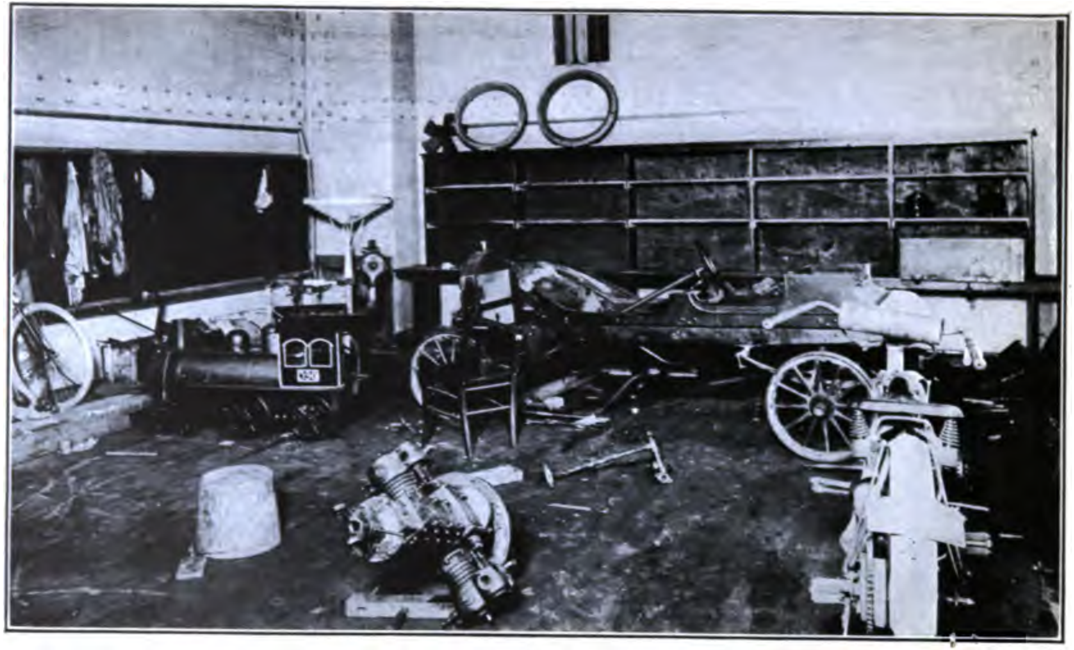
[2] See illustration opposite page 60.

A term of thirteen weeks was devoted to the study of physics by the grades. The course was based upon twenty-five experiments. Before performing an experiment, the instructor endeavored to elicit from the pupils their experiences and observations bearing directly or indirectly upon it. The metric system was made real by requiring that pupils weigh and measure freely in both metric and English systems, thus learning how to convert one into the other; the relations of diameter and circumference were experimentally ascertained as the basis of developing the formula expressing them; various bicycle gears and their different effects were studied; thermometers, ice machines, ventilation, water, gas and electric meters, automobile engines and other topics were taken up in the same fashion; appliances were observed and experimented with and gradually the pupils were led back to the underlying principles and laws. Finally, throughout the course, the pupils were required to make in their notebooks lists of new words used in the physics course.

As illustrations of the manner of conducting the work of the elementary school pupils, an exercise dealing with the manufacture of electric cells, and an exercise dealing with the use of wheels of different sizes, may be described.

At the outset six metals were tested in pairs in order to determine which pair gave the strongest electrical current when placed in a weak solution of sulphuric acid. The pupils worked in small groups, each making his own record of results observed and the methods by which they were secured. One fourth grade boy having been absent on the preceding day had missed the introductory experiment made to develop an electric current. Hearing what had been done the day before, he went off by himself with the materials needed, tried the experiment himself, and prepared the records of his results with as constant interest and faithfulness in performance as could ordinarily have been secured from a much older student.

For the study of the relations between wheels of different sizes a number of small wooden wheels or disks of various sizes are provided. The pupils are taught how to determine the circumference by rolling a disk for one complete revolution upon the table, then measuring the distance covered. A good many trials are required before some students could see the relation which exists between the circumference and the diameter, but a few students succeeded in four or five trials in determining the relation. A written report of the experiment is required and the arithmetical work involved is of a practical nature.



Repair Room, Physics Laboratory—Emerson School

Bicycles are brought into the room and the pupils are required to determine the "gear" of the different machines. The instructor stated that an ordinary class will be able to determine the gear of two differently geared bicycles in a laboratory period of sixty minutes. The following is an outline of the questions and directions given to the pupils for this work:

Object—to find the gear of two different bicycles.

Apparatus—bicycle and measuring stick.

Manipulation—Count the number of sprockets in both the large and small sprocket wheel. Measure the diameter of the rear wheel including the tire. To find the gear multiply the diameter of the rear wheel by the quotient obtained by dividing the number of large sprockets by the small sprockets.

Wheel No. 1.

Number of sprockets in large sprocket wheel———.
Number of sprockets in small sprocket wheel———.
Quotient = number of large sprockets ÷ number of small sprockets———.
Quotient × diameter = ———gear.

Wheel No. 2.

Number of sprockets in large sprocket wheel———.
Number of sprockets in small sprocket wheel———.
Quotient = number of large sprockets ÷ number of small sprockets———.
Quotient × diameter = ———gear.

Conclusion—Does the high or low gear cause the wheel to run the faster?
Which is easier to push up a grade or against the wind?
What class of lever is used in the pedal chain and sprocket wheel of a bicycle?
Where is the force located? The weight? The fulcrum?

Spelling—
1. gear
2. sprocket
3. rear
4. quotient
5. bicycle
6. coaster
7. pedal
8. spoke
9. speed
10. velocity

The bicycle offers a good problem for pupils in determining the relation between fulcrum point and application of force and weight in the bicycle pedal. Also the idea of levers is well illustrated in the use of scales, teetering board and wheelbarrow, and all of these are used in this experiment.

This exercise also serves to illustrate the correlation between physics and shop work. After the preceding calculations, the class is taken to the machine shop, where there is a machine with a belted wheel and a motor. The pupils calculate the comparative diameters of the belted wheel of the motor and the belted wheel of the machine to be driven. The instructor checks the pupils' measurements by the exact facts as determined by himself or recorded by the engineer who installed the machinery. The number of revolutions of the two wheels is determined; in this way the pupils gain an impression of how increasing the speed of one wheel may result in a change in the nature of the work that may be accomplished by a wheel of a different size.

The high school course in the same subject was based on one of the more comprehensive high school textbooks. The course did not appear to differ materially from that given in any one of a large number of high schools.

At the Froebel school the physics work of the elementary grades was of the same general character as that of the Emerson school, but it was less efficiently managed. Experiments were performed and demonstrations made in the presence of the children who were encouraged to comment and ask questions. But in the lessons observed, the questions were neither well answered nor directed toward further experiments and the phenomena were not well explained. In consequence, an unfavorable judgment must be recorded on the ground that the course was both inconsequential and unorganized.

In the Froebel high school, no outline of the work was procurable, though one of the commonly known textbooks was in use. The complete list found in the students' notebooks showed the range of the experimental work undertaken. Forty experiments covering the usual high school course in physics were outlined in one notebook. In other notebooks examined, the number of experiments recorded varied considerably: one contained 32, another 25, still another 18. In the classes visited, it was clear that the day's work had not been carefully planned or foreseen, but was, more or less, controlled by chance. Nor was the teacher's standard sufficiently exacting. Experiments described in the pupils' notebooks were at times "approved" or "o. k.'d" with the teacher's initials added, despite serious errors in calculation, spelling, and plain evidence that the phenomena described were misunderstood and incompletely recorded.

IX. CHEMISTRY

THE Emerson and Froebel schools have each a commodious room which serves at once for recitation, lecture, and laboratory purposes. Each has an adjoining photographic room. The equipment provided is of the usual type to be found in satisfactorily equipped high schools; in addition, appliances of industrial character are found.[1]

Chemistry is scheduled as being taught to sixth and eighth grade classes in the elementary school. In the high school it is elective, primarily in the second year, but is available to pupils in later years of the high school. No statement showing the details of the elementary school course in the Froebel school was procurable; on the occasions when the classes were visited the pupils were working with cameras; but it was clear that no organized course of instruction was pursued. At the Emerson school a syllabus for the sixth and eighth grade classes had been prepared as follows:

September—Enrollment and organization of classes.
Work on solution and crystallization.
October —Starch conversions.
November—Carbon and carbon compounds.
December—Fermentation.

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[1] See illustration opposite page 62.

January —Nitrogen.
February —Oxygen.
March —Carbon dioxide.
April —Solvay process for soda.
May —Hydrogen, water.
June —Juices of fruit as a solution.

On the occasion of one visit the instruction was conducted by a teacher with a high school pupil acting as assistant. The class, numbering 27, of whom 6 were helpers, was divided into groups of 3 or 4. The class was engaged in making oxygen from chlorate of potash, according to specific directions which were written by the pupils at the teacher's dictation. It was perhaps not without significance that a group of pupils in charge of the student assistant was wrongly advised regarding the things to be done, with incorrect results. No comment or explanation was made by the instructor at the time when his attention was called to the mishap.

The high school course at the Froebel school was described as based upon a textbook supplemented by work on the various processes involved in the manufacture of steel. In the absence of outlines or notebooks this work could not be inspected; but during none of the visits to the class was any work of a supplementary character observed and no adequate outline of the work was available.

In the Emerson school the high school work in chemistry is of an industrial nature, relating to several important industrial processes. For example, the coal used by the schools of Gary is tested by the chemistry class under the direction of the chemistry instructor. Samples taken from each wagon load of coal delivered to the school during any given month are locked in a metal sample can. They are then ground together so that a composite sample of the kinds of coal furnished for the entire month is secured. This composite sample is used for examination and is tested for calorific value early in the following month. It is stated that the results of the test are reported to the office, which on the 15th of each month pays the companies supplying the coal, basing the payment upon the pupils' reports as to the calorific value of the coal furnished. It was further stated by the superintendent of schools and the head of the chemistry department that the work of the pupils is sufficiently accurate to be entirely satisfactory to the companies furnishing the coal and to the school authorities.

Another experiment conducted by the high school class in chemistry had to do with the use of dyes of different kinds in commercial jellies. Pupils tested jellies purchased from a number of shops, in order to determine, first, whether glucose was present and if so in what percentage; second, whether cane sugar was present, and in what percentage; and third, what coloring materials had been employed.

Still another type of work had been developed in coöperation with the City Health Department and the food inspector. The instructor in chemistry in the Emerson school directed the work of the paid assistants who ex-

Physics Laboratory—Froebel School

amine food and conduct bacteriological tests for the Board. High and elementary school pupils were assisting, six at a time being assigned to the work after school hours. Each pupil must serve 133 hours in this work in order to secure one school credit. The pupils plated the milk samples to determine the number of bacteria present, washed and sterilized the glassware, measured the samples, labeled the plates, counted the colonies and estimated the number of bacteria per cubic centimeter.

The teacher, together with the Board of Health assistant, the city food inspector and Board of Health officers, also conducted inspection trips with pupils. On these trips conditions of dairies, kinds and conditions of cows, and handling of milk containers and of milk were noted. Undesirable conditions were made the subject of official criticism to the owners in the presence of the pupils. Good and bad conditions alike were discussed with the owners. Subsequently compositions were written about these trips and these compositions were used as science and language lessons. At times auditorium exercises based upon the inspection trips were given before the entire school. There can be no question that substantial results, practical as well as educational, have been thus obtained, as is witnessed by the following composition by one of the pupils:

CONDITION OF CONTAINERS

The milk pail is an important utensil in the production of clean milk. In pails where the dirt which falls in does not remain, where the streams of milk strike against it, a strainer cloth aids in keeping down the number of bacteria which gain access to the milk. The metal strainer is safer where milkers are careless, as they will handle cheese cloth strainers and lay them down in dirty places. But we can obtain good results from cheese cloth if the milker is careful and sanitary cheese cloth is used. Milk pails should have all seams smoothly covered with solder. The aluminum pail is best because it is made in one piece without joints.

After milking, all the utensils should be rinsed at once with cold water, then washed with hot water and washing-soda, and rinsed again in clean, cold water. Finally, all the metal dairy utensils should have boiling water poured over them, which sterilizes and dries them at once. Dairy utensils should never be dried with towels. Cans should be scalded with boiling water or have steam turned into them and be placed upside down so that air also may be admitted. Rusty cans should never be used as they sometimes give milk a fishy taste. This fishy flavor is said to be given to milk when washing soda is not well rinsed from dairy utensils. When the cans become much dented they are difficult to clean and should not be used. In Gary, if a rusty can comes into the city the milk is dumped out and a bright red label placed upon the can, saying that it is not to be sent with milk again. It is then sent to the owner and if it is again sent to the city with milk it is destroyed.

Some people can remember when milk was peddled from house to house in a wagon, having one or two large pails, from which the milk was dipped or drawn from faucets near the bottom of the pails.

It is only within the last twenty-five years that the glass milk bottle came into general use. Then we thought all our troubles were at an end. It was soon found, however, that the glass milk bottle might be a source of real danger. The most danger against it is that it is likely to become infected and spread disease. Further, they are difficult to keep clean. The bottle may become infected in the household in many ways. For instance: A person with diphtheria may drink from the bottle, or it may have been wiped with a cloth which has been infected from a case of typhoid fever. If such a bottle is again filled with milk without proper disinfection, grave consequence may ensue. The manner in which milk bottles are cleaned at a dairy before they are again filled with milk would not meet the approval of a careful housewife. Therefore, milk bottles should always be thoroughly cleaned by the householder before they are returned to the dairy.

Milk wagons should be kept in a good condition, also. A wide step

Chemical Laboratory—Emerson School

should be affixed to the wagon behind on which the driver may stand when getting bottles at the rear of the wagon. A sheet iron floor with an open slit at either side running the whole length to permit water draining is a good idea. The wagon should be kept well painted for the good of the milk and for looks, also. If milk is allowed to remain on the floor, dirt and disease may collect to contaminate the milk. It is a good idea to have the ice placed in the boxes where the milk is kept.

X. TESTS

IN RECENT years much attention has been devoted to the preparation of tests in the usual school subjects, and in some subjects a considerable amount of comparative data has been assembled. Thus, tests in spelling and in certain arithmetical operations have been given to such large numbers of school children working under fairly uniform conditions that standards of performance have been established in those subjects. In reading and composition progress has been made. There are as yet no accurate standards by means of which to test the results of science teaching in any adequate way. Our confidence that the study of science is valuable is based upon general observation and reasoning, rather than on definite demonstration in the form of the results actually secured.

Though, for the reasons stated, it was impossible to measure the science teaching at Gary as the teaching of some other subjects was measured, efforts were nevertheless made to determine by practical tests what amount of ability pupils possessed in the observation, discrimination, and interpretation of phenomena. The tests utilized were intended to include:

(1) Some elements or features so simple that only

distinctly poor pupils would fail to give acceptable responses to them;

(2) Some elements which would elicit acceptable responses from the majority of pupils who had attained the types of ability in question;

(3) Some elements to which acceptable responses would be made only by those pupils who possess the types of ability in question in a marked degree.

It is not possible as yet to state how much harder the elements last mentioned are than those first mentioned, but the kind of difference in question may be illustrated by reference to an observation and discrimination test based upon two bird pictures, in one of which the bird has a distinct "top-knot" and a small and inconspicuous hook-tipped bill, while in the other the bird has no "top-knot" but has a straight-tipped bill. Nearly all pupils tested noted the first points of contrast, and only quite accurate observers noted the second point.

Nine tests were used in the five eighth grade classes in the Emerson, Jefferson and Froebel schools, and in the seventh grade in the Beveridge school; and in the twelfth grade high school classes in the Emerson and Froebel schools. The tests may be classified into three groups, though the particular feature tested in any one group necessarily appears in some measure also in each of the other groups.

The first group dealt with observation and discrimination based upon objects which were placed before the pupils. This group consisted of two pairs of tests, each pair including one test in observation and discrimination based upon objects which, superficially at least, were quite different, and another test based upon objects which, superficially at least, were less different. For example, the first test was based upon a leaf from a white oak tree and one from an elm tree, each pupil having before him the pair of leaves, with instructions to indicate all the differences by means of which he could distinguish one of the leaves from the other. Following this test was one based upon a leaf from a white oak tree and one from a red oak tree. In the other pair of observation and discrimination tests, the first one was based upon colored pictures of the kingbird and the kingfisher, birds which are strikingly different; and the second upon the kingbird and crested flycatcher, birds which at first glance are less readily distinguished.

The second group of tests relates primarily to the pupil's ability to recognize natural phenomena, to recall experiences in science study, and to make constructive statements regarding these experiences. The first of these tests was based upon accurately colored pictures of common birds, each pupil having before him a card with the pictures upon it, from which he was to recall and then write the names of the birds. Of the two other tests in this group, one was based upon the names of ten common birds, the other upon the names of ten common insects, each pupil being asked to select four from each list of ten and to answer certain questions about each of the four birds and the four insects which he selected.

The third group consisted of two tests of ability to give reasons for, to interpret, or to explain changing phenomena, the changes occurring in the presence of the pupils in the form of an experiment or demonstration. One of these tests was based upon certain facts related to gravity, the space-occupying property of air and the fact that water is heavier than air. The other test dealt with the fact that heated air is crowded upward by incoming colder air.

It should be emphasized that these tests cannot be said to do more than test abilities as related to the particular objects and processes used in these particular test experiments. The extent to which the results may be related to abilities in thinking about other science materials cannot be known until further investigations have been made; nor do these tests show the extent to which the results were due wholly to instruction in science alone. The pupils, so far as is known, had had no specific training in the use of the exercises upon which the tests were based, but in most cases they had more or less science work of types supposed to give acquaintance with common phenomena and to develop observation and discrimination.

The pupils tested were asked to indicate whether they had pursued nature study, elementary or general science, physiology, physiography, botany, zoology, physics, chemistry, or agriculture. Of the 191 reporting in the elementary school classes, 133 stated they had studied science of some kind; 47 that they had not; 11 did not answer this question. Since the reports by the same pupil differed on this point in different papers, the above figures regarding previous science studies cannot be regarded as entirely reliable. Pupils were also asked to indicate how long they have been in the Gary schools. The length of time varied from one year to nine years (nine years in only two cases). In one case an eighth grade pupil had entered the school the day before the information was asked for. The average number of years in the Gary schools for 184 of the 191 elementary school pupils, as reported by the pupils themselves, was 4.97 years. The remaining seven pupils did not answer the question.

TEST NUMBER I

On each of forty plain gray cards, 11 x 14 inches in size, there was mounted a pair of leaves, one from an elm tree and one from an oak tree, each leaf properly named.[1] Each card was numbered so that any evidence of individual variations in the leaves might be checked, in case such evidence appeared in the answers. The leaves had been carefully collected, dried and mounted so as to secure as nearly as possible a uniform set of leaves. It must be kept in mind that the materials were prepared, not for instruction regarding the leaves of elms and oaks, nor to test ability to discriminate between oak and elm leaves in general, but to test ability to observe and discriminate between characteristics of the two leaves which were placed before the pupil.

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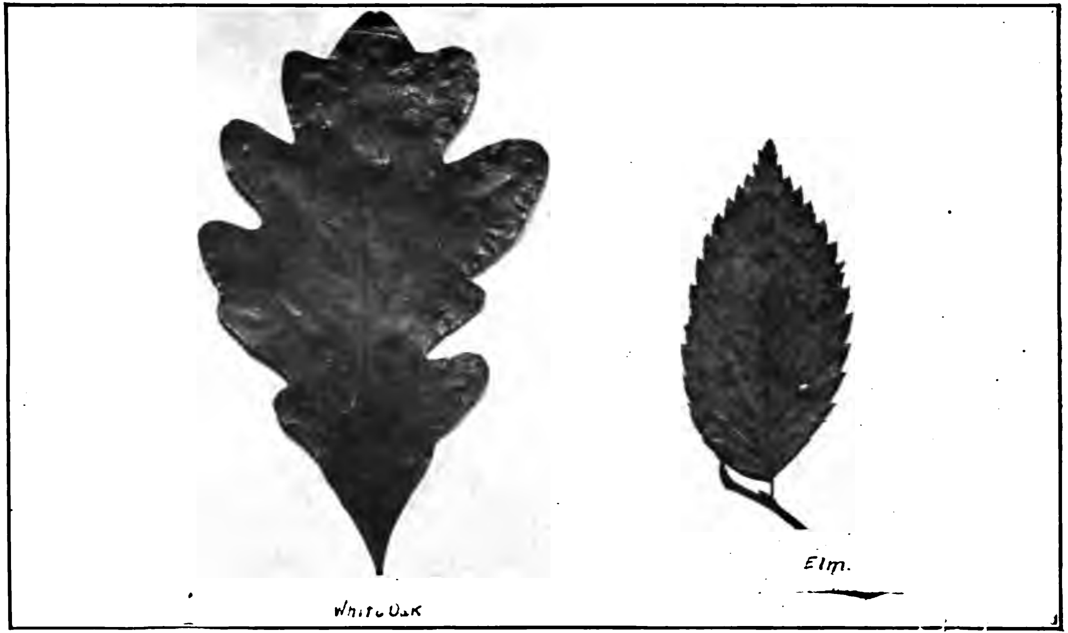
[1] See Figure 2, opposite this page.

FIGURE 2

THE LEAVES USED IN TEST I



SCIENCE TEST NO. 1[1]

Read all of this sheet first.

Directions: In this exercise you are asked to use this sheet and some specimens which are fastened to the lower side of the card which is placed face downward upon your desk. Do not turn the card until told to do so. Fill in the personal data blanks below.

In the following underscore the proper number: This is my 1st, 2d, 3d, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th year in the....................School.

In the following underscore any of the subjects you have studied: I have studied nature study, elementary science, geography, general science, physiology, physiography, botany, zoology, physics; chemistry, agriculture.

Although this is not a test of speed, it is important to record the time of beginning and of closing your work. When told to do so, enter the exact time in hours and minutes in the first time blank; then turn the cards and do the work requested; and then enter the time of finishing.

Time when work is begun....................Grade of pupil..................Boy or girl
Time when work is completed..................Name of pupil............................
Date...................................

The specimens of leaves which you have are of the white oak tree and of the elm tree, and this exercise has nothing to do with any other leaves except the two here shown. In the spaces below state all of the differences by means of which you can tell one of the leaves on the card from the other one on the card. After writing your statement, if you wish to do so you may also make sketches to show the distinguishing features. You may use both sides of the sheet if you wish.

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[1] The size of type and the amount of space for answers were much larger in the test sheets used.

The cards and printed blanks were placed face downward upon the pupils' desks, the pupils being told not to turn them over until directed to do so. When all were distributed, the pupils were told to turn the blank sheets, to read the directions as the instructor read them aloud, and then fill in the personal data called for. When the personal data had been entered, the pupils were given the hour and minute to be entered in the first time blank, then told to turn the cards, and go to work.

The blank for test 1 appears on page 69.

After studying a large number of answers which were given, a list of the points which might be expected in a complete answer to the test was prepared. This list, which was used as the fact-basis for scoring or grading the papers of test 1, is as follows:

1. Shape or form of the leaves.
2. Size of the leaves.
3. Color and color markings.
4. Surface—rough, smooth, hairy, uneven.
5. Margin—appearance, notched margin, smooth or toothed margin.
6. Midrib—present, absent, heavy, light.
7. Veins—present, direction, free or joining.
8. Stems—size, length, form.
9. Base—form.
10. Apex—form.

Two systems of scoring results were used in all the tests, one, the percentage grade system, the other, the point system. In scoring under the percentage grade system, a definite value was assigned to each of the parts of a complete answer. For example, in test 1, in which there are ten parts recognized, each one was given a value of 10, and the whole a value of 100. The relative difficulty of each of the parts of the complete answer is not known. It would seem that one could establish the relative difficulties of these parts only as a result of a long series of tests in which tabulation is made of the actual relative accomplishment of many pupils who have had all parts of each test. In certain tests the different parts of which obviously vary in difficulty, a difference was made in the numerical value assigned to each part. The difficulty in assigning a definite value to each part of a test does not necessarily vitiate the value of a test, since if all papers are scored faithfully upon any assumed value for each part, the relative positions of the different pupils whose work is scored is likely to be the same as if other assumed values had been assigned. However, the assigning of definite percentage scores to parts of tests when the relative difficulties of these parts are unknown gives an unjustified appearance of accuracy and may be misleading. The percentage scores are not presented, therefore, but the method used in presenting the pupils' standing in all the tests is designated as the point system. The points used as the basis of the percentage grading are used as the basis of this system, but the system is planned for the purpose of avoiding the assignment of definite numerical percentage values to each part of the tests. A reasonably satisfactory answer to one point is given a "+" mark; an answer which misses the point, or a failure to answer is given a "—" mark. An answer which contains some merit but which is lacking in important features is given the intermediate mark "y." The point system of scoring makes it possible to show whether a pupil did or did not observe or interpret the points in question without undertaking to state the relative difficulties of the different observations or interpretations. When returns from a large number of pupils have been secured, it may be possible in connection with studies elsewhere to assign numerical values to the different elements of the tests used.

A few representative answers are given below in order to indicate the nature of the responses. The pupil numbers here used bear no relation to the pupils' ranking, each pupil having been assigned a number which is used for that pupil in all tests. The grade and score in number of points answered satisfactorily are also given. In test 1, a complete answer included ten points as the responses were analyzed. In printing the pupil's answers no corrections have been made in sentence structure, spelling, or terms used. Replies have been selected from each of the four schools in which the tests were given.

Beveridge Class No. 12.

Pupil No. 26.

"The oak leaf is larger than the elm. The edges of the elm point sharply upward. The edges are uneven and rough. The white oak leaf are not sharp. The points of the elm are small but there are many of them. The points of the oak are large and there are only a few of them. The veins of the elm are finer than of the oak. The elm is covered with short hairs. The oak is smooth."

Grade 7, Score + 4, y 1, — 5

Pupil No. 29.

"The oak is long and has about ten curves and other curves on the tips. It has one large vein running up these curves and many little ones coming out at the sides. The oak is narrow toward the bottom, and broad at the middle, while at the top it is not so narrow as it is on the bottom. The elm is not so long and not so wide as the oak leaf. It has tiny little points running all the way up to the point. This leaf is quite the shape of an egg except that the egg does not point at the top or bottom as the elm leaf does."

Grade 7, Score + 6, y 1, — 3

Jefferson Class No. 18.

Pupil No. 29.

"The oak leaf has a large stalk running up the center of the leaf. The veins are heavy and have little veins branching off from the larger veins these are very little. The shape is different from that of the elm. It has big cuts in it. The elm leaf has a delicate stalk running up the center. The veins are very fine they take a sort of curve to the top. It has only a few veins branching off. The outer edge of this leaf is very ragged."

Grade 8, Score + 9, y 0, — 1

Emerson Class No. 14.

Pupil No. 25.

"The leafs of the oak are much larger than those of the elm. The oak is very long and has deep impressions on the margin or edge while the elm is not nearly so long and the impressions are not nearly so deep. The impressions of the oak form little finger-like prongs while the impressions of the elm simply make a scallop around the edge. You can see the smallest division of the veins in the oak, while on the elm you can not see hardly the one branch from the main branch. The stem with which the oak is fastened to the tree is broader at the end and grows thinner as it nears the green part of the leaf. The stem of the elm is the same size all the way up or down. At the upper end of the elm it comes to a sharp point and at the bend of the oak are three divisions.

"The oak has finger shaped projections. The elm has scalloped edges."

Grade 8, Score + 6, y 1, — 3

Emerson Class No. 15.

Pupil No. 13.

"The oak has larger sclept than the elm. The vains are bigger. The elm has more vains. The elm has sharper points and is smaller."

Grade 8, Score + 1, y 2, — 7

Froebel Class No. 45.

Pupil No. 9.

"The dents or scallops of the white oak are far apart. The oak has large dents or scallops and a vein goes from the middle vein to each scallop or dent, and the leaf is covered with tiny veins all over it while the elm leaf has a tiny scalloped edging and veins going from the middle vein to each scallop. The scallops are very close together, the leaf has no tiny veins all over it. The oak is longish or more slender while the elm leaf is short and round. The oak is two times as large as the elm and very much lighter. The elm has a short stem and the oak has a stem three times as large."

Grade 8, Score + 6, y 1, — 3

Pupil No. 7.

"The veins of the elm leaves are parralel viens while the viens of the white oak run in all directions. The edge of the elm leaves are very sticky."

Grade 8, Score + 1, y 2, — 7

Froebel Class No. 46.

Pupil No. 2.

"The oak leave is cut in very deep and has about 11 cuts while the elm's leave is cut very little and contains great numbers of this cuts."

Grade 8, Score + 1, y 0, — 9

In Chart I[1] there is presented the record for each of the pupils of the Jefferson school eighth grade class on test 1. A study of this chart will show:

1. Each pupil has a number. This number represents this particular pupil in this class throughout all the nine tests.
2. If a pupil was absent on the day when the tests were given, his number appears, but his line on the chart is left blank.
3. The time in minutes consumed by the pupil in doing the work is recorded. This time does not include the time used in filling in blanks which ask for personal information.
4. The topic headings of all points, ten in all in this test, are given and the pupil's +, y, or — score is indicated below. At the right is the summary of individual scores.
5. The scoring is first given for the boys in the class, then for the girls, then a summary of boys and girls combined.

Pupil No. 28, for example, answered four points satisfactorily, partially answered two, and did not respond or gave incorrect responses on four points. If this pupil's two partial answers or "y" scores are each scored as half-correct and these added to her + scores, she would have a score equal to satisfactory answers to one-half the whole number of points. Her score is + 4, y 2, —4, or if the y scores are combined with the + and

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[1] See page 76a.

— scores, the whole would be + 5, —5. Similarly pupil number 29, who made a most favorable score, is represented as + 9, —1, but in this case none of the + scores is due to redistribution of y scores. If pupil number 14 is compared with pupil number 31, it is seen that their respective scores are + 5, y 0, — 5; and + 4, y 2, — 4. By redistributing the y score of number 31 the whole score for pupil number 31 would read exactly as the score of pupil number 14. Since it is decidedly questionable whether two indefinite, though partially correct answers, are really equal to one clearly satisfactory answer, the y scores are not regularly combined with the + scores, but are summarized separately.

It is also shown in Chart I that the mean number of replies for the 9 boys who were present when the test was given is +4.1, y 1.7,—4.1; and for the 16 girls who were present is + 5.0, y 0.6,—4.3. The girls in this class on this test not only made a higher mean + score than the boys, but made a lower y score, and almost the same — score.

In the summary the distribution of the class upon the basis of the + scores is given. The low score is 1, the high score 9, the mean 4.6. Fifteen of the pupils (6 boys and 9 girls) are below and 10 (3 boys and 7 girls) above the mean.

Study of the vertical columns of pupil scores shows that there is a wide range between the value of responses on different points. Points 2, 5 and 7 when combined received more + answers than all the other 7 points com-

CHART I

SCIENCE TEST NO. 1 . JEFFERSON SCHOOL CLASS 18 GRADE 8

Pupil's No.	Time for Answer (min.)	Point 1 Shape	Point 2 Size	Point 3 Color	Point 4 Surface	Point 5 Margin	Point 6 Midrib	Point 7 Veins	Point 8 Stem	Point 9 Base	Point 10 Apex	TOTAL		
												+	y	—
Boys														
1	16	y	y	—	—	y	+	+	+	—	y	3	4	3
2														
3	12	y	+	y	—	y	—	+	+	y	+	4	4	2
4	16	+	y	+	—	+	+	+	—	—	—	5	1	4
5	12	y	+	—	—	+	+	+	—	—	—	4	1	5
6	8	+	+	—	—	+	+	y	—	—	—	4	1	5
7	12	+	+	+	+	y	+	+	+	—	+	8	1	1
8														
9	11	—	+	—	—	y	—	—	—	—	—	1	1	8
10														
11														
12	10	y	+	+	—	+	—	+	+	—	—	5	1	4
13	10	+	y	y	—	+	—	+	—	—	—	3	2	5
Number of + answers		4	6	3	1	5	5	7	4		2	37		
Number of y answers		4	3	2		4		1		1	1		16	
Number of — answers		1		4	8		4	1	5	8	6			37
							Mean number of points					4.1	1.7	4.1
Girls														
14	12	—	+	+	—	+	+	+	—	—	—	5		5
15														
16	7	y	+	—	—	+	y	+	+	+	+	6	2	2
17	10	—	+	+	—	+	—	—	—	—	—	3		7
18	16	y	+	—	—	+	+	+	—	—	—	4	1	5
19	15	y	+	—	—	+	+	+	—	—	—	4	1	5
20														
21	11	+	+	+	—	y	—	+	—	—	—	4	1	5
22	?	+	+	—	—	+	+	+	+	+	+	8		2
23	19	+	+	+	—	+	+	+	+	+	+	9		1
24	11	y	+	—	+	+	—	+	+	—	—	5	1	4
25	15	+	+	—	—	+	+	+	y	—	—	5	1	4
26														
27														
28	15	—	+	y	—	+	+	+	y	—	—	4	2	4
29	16	+	+	+	—	+	+	+	+	+	+	9		1
30														
31	11	y	+	—	—	+	+	y	+	—	—	4	2	4
32	8	+	—	—	—	+	—	+	—	—	+	4		6
33	14	—	+	—	—	+	—	+	+	—	—	4		6
34														
35	10	—	+	—	—	+	—	—	—	—	—	2		8
36														
Number of + answers		6	15	5	1	15	9	13	7	4	5	80		
Number of y answers		5		1		1	1	1	2				11	
Number of — answers		5	1	10	15		6	2	7	12	11			69
							Mean number of points					5.0	0.6	4.3
Boys and Girls														
Number of + answers		10	21	8	2	20	14	20	11	4	7	117		
Number of y answers		9	3	3		5	1	2	2	1	1		27	
Number of — answers		6	1	14	23		10	3	12	20	17			108
							Mean number of points					4.6	1.0	4.2

Summary of Individual Pupils (+) Scores

Lowest + score	1	Mean + score	4,6	Highest + score	9
Boys below mean	6	Boys with mean score	0	Boys above mean	3
Girls below mean	9	Girls with mean score	0	Girls above mean	7

bined. This is interpreted as meaning that the other 7 points are more difficult than points 2, 5 and 7, and that a + or y reply on one of these 7 points is of more value proportionately than similar answers on points 2, 5, and 7.

In order to study the results obtained through giving the nine science tests to six elementary grades and two high school classes at Gary, summaries were made of each test for all the schools, and for each class and for each school upon all the nine tests. These and other similar studies resulted in the construction of more than ninety charts which classify and depict the results in detail. It would be useless to include in this volume all this material. Instead there is presented in connection with the description of test 1 a sample detailed class chart; there is then presented in Chart II a summary of the elementary school classes which shows the distribution of the total scores for each class.[1]

A study of the returns from six classes[2] in four schools shows that 116 of the 150 pupils made satisfactory observations regarding the distinctions between leaf margins. In addition to these 116 satisfactory observations, 26 others made partially satisfactory answers on this point. On the other hand, but 9 satisfactory reports of the 150 were made regarding the distinction between the surfaces of the leaves, and but 4 partially satisfactory reports were made upon this point. Similarly 104 satisfactory records were obtained regarding veins and 26 additional partially satisfactory records; while the distinction that the elm leaf has a "lop-sided" base and the oak does not, received 9 satisfactory records and 8 partially satisfactory ones.

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[1] As stated above, only + replies are shown in this table. Other data appear in unpublished charts.

[2] See Chart II, page 78a.

In Chart II,[1] a summary of scores on test 1 for six elementary classes, it will be noted that the Beveridge class is presented separately since it was a seventh grade class. In this, as in most of the other tests, the Beveridge seventh grade class has a lower score than the eighth grade classes in the other schools. The class is not only one year less advanced but the principal of the school stated that this class had had little elementary science work since the primary grades.

The chart also shows:

a. Each point receives responses from some of the pupils.

b. Points 1, 2, 3, 5, and 7 receive a very considerable number of correct responses, almost one-third of the pupils reply correctly on points 6 and 10, but only one pupil in 16 replies correctly on points 4 and 9.

c. The number of y replies averages 1.1 for the 150 pupils.

d. The summary of individual pupil plus scores in each class shows the low score in each class was 1, the highest score was 9, but in all classes but one, the high score was 6. Thirty-eight boys and 34 girls are below their class mean, while 27 boys and 51 girls are above their class mean.

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[1] See page 78a.

SCIENCE TEST NO. 1

SCHOOL	NO. OF CLASS	NO. OF PUPILS IN CLASS	NUMBER O	
			Point 1 Shape	Point 2 Size
(Boys)				
Emerson......	14	16	5	6
Emerson......	15	15	6	9
Froebel.......	45	7	1	1
Froebel.......	46	6	4	3
Jefferson......	18	9	4	6
Total for 5 classes......		53	20	25
Beveridge.....	(7th Gr.)	12	7	6
Total for 6 classes......		65	27	31
(Girls)				
Emerson......	14	19	5	17
Emerson......	15	18	8	12
Froebel.......	45	7	3	3
Froebel.......	46	9	3	6
Jefferson......	18	16	6	15
Total for 5 classes......		69	25	53
Beveridge.....	(7th Gr.)	16	4	9
Total for 6 classes......		85	29	62
(Boys and Girls)				
Emerson......	14	35	10	23
Emerson......	15	33	14	21
Froebel.......	45	14	4	4
Froebel.......	46	15	7	9
Jefferson......	18	25	10	21
Total for 5 classes......		122	45	78
Beveridge.....	(7th Gr.)	28	11	15
Total for 6 classes......		150	56	93

SUMMARY OF

Lowest + score........................
Mean + score..........................
Highest + score.......................
Number of boys below mean............
" " girls " " ....
" , " boys with " score........
" " girls " " " ....
" " boys above mean............
" " girls " " ....

e. The boys have a lower mean score than girls in their own classes in all schools except the Beveridge, in which boys and girls have the same + score and show only insignificant differences in their other scores, except that there are 10 girls and 6 boys below the mean.

TEST NUMBER 2

The preceding rather complete description of test number 1 will make it possible to present more briefly the essential features and results of the remaining tests. Different classes are selected for the different sample class charts in order to show the class variations.

Test number 2 was designed to test ability to make comparisons by use of materials[1] which are seemingly more alike than those used in test 1, though the materials really include points similar to those of test number 1. On page 80 is a copy of the test blank.

The following sample answers quoted from pupils' papers will indicate the nature of the reactions given:

Jefferson Class No. 18.

PUPIL No. 1.

> "The White Oak is small towards the Red Oak it has more rounded edges its stem is shorter its fibers cannot be seen as plainly as on the red Oak it is more greenish than the Red Oak. The Red Oak is large has pointed edges is reddish in color its fibers can be seen plainly and it has a longer stem than the white Oak."
>
> Grade 8, Score + 5, y 0, — 5

PUPIL No. 18.

> "Both have scallops on the leaf. The white oak scallops are round at the end which the red oak scallops are pointed. The white

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[1] See Figure 3, opposite page 80.

SCIENCE TEST NO. 2

Read all of this sheet first.

Directions: In this exercise you are asked to use this sheet and some specimens which are fastened to the lower side of the card which is placed face downward upon your desk. Do not turn the card until told to do so. Fill in the personal data blanks below.

In the following underscore the proper number: This is my 1st, 2d, 3d, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th year in the....................School.

In the following underscore any of the subjects you have studied: I have studied nature study, elementary science, geography, general science, physiology, physiography, botany, zoology, physics, chemistry, agriculture.

Although this is not a test of speed, it is important to record the time of beginning and of closing your work. When told to do so, enter the exact time in hours and minutes in the first time blank; then turn the cards and do the work requested; and then enter the time of finishing.

Time when work is begun......................Grade of pupil..................Boy or girl
Time when work is completed..................Name of pupil.............................
Date...

The specimens which you have are of the white oak tree and the red oak tree. In the spaces below state all the differences by means of which you can tell one of the leaves on the card from the other one on the card. After writing your statement, if you wish to do so you may also make sketches to show the distinguishing features. You may use both sides of this sheet if you wish.

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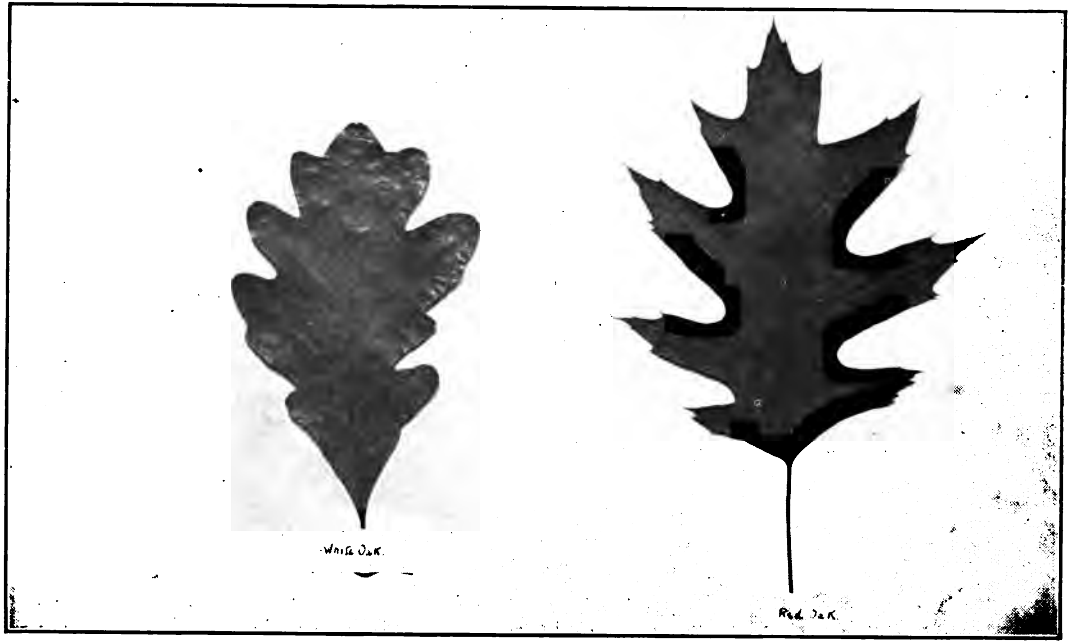
FIGURE 3

THE LEAVES USED IN TEST 2



White Oak

Red Oak

oak has more scallops than the red oak, it sometimes has six or seven, while the red oak has five or so. The red oak is a much darker green. It is also longer than the red oak. The veins on both go to the points and the scallops. I think the red oak has a darker thicker middle rib than the white oak. At the end of the leaf the stem is longer on the red oak."

Grade 8, Score + 6, y 1, — 3

Emerson Class No. 14.

PUPIL No. 5.

"A red oak leaf is larger than a white oak and its parts come to a point and in these parts there are many other parts which come to a point. It also has big scollops between the parts. A white oak is smaller and its parts come around at the end."

Grade 8, Score + 2, y 0, — 8

PUPIL No. 25.

"The white oak is much smaller both in height and width. The red oak is a darker green. Each finger like indentation on the red oak has three points very sharp ones and little thorn like projects. The first indentation of the white oak is very small while that of the red oak is as large as the largest on the white oak. You can see the branches of the main veins much plainer on the red oak. The beganning of the leaf goes more gradually after starting of the white oak than the red."

Grade 8, Score + 6, y 2, — 2

Froebel Class No. 45.

PUPIL No. 10.

"The white oak leaves are round at the ends. The stem is not so long or thick as the leaves of the red oak. The white oak has fingers. The finger leaves of the red oak are pointed at the ends. At the ends of the finger leaves are little green things that looks like green thread. Some of these green threads are round and others are straight. The veins of the red oak are wider and longer than the veins of the white oak."

Grade 8, Score + 3, y 3, — 4

Froebel Class No. 46.

Pupil No. 18.

"The scallops of the red oak are very pointed and long. The scallops of the white oak leaf are broad and short. The color of the white oak is a bright shiney green while the other is a dull green. The white oak is broader in proportion than the red oak leaf. The red oak leaf has sharp points on each tip which prick. The white oak leaf has fewer scallops."

Grade 8, Score + 4, y 1, — 5

By means of a study of the responses the following points to be considered in scoring are recognized, these being the same as the points used in scoring results from test 1.

1. Shape or form of the leaves.
2. Size of the leaves.
3. Color and color markings.
4. Surface—rough, smooth, hairy, uneven.
5. Margin—appearance, notched, smooth, toothed, irregular or regular.
6. Midrib—present, absent, heavy, single, branched.
7. Veins—present, direction, free or joining.
8. Leaf stem—size, length, form.
9. Leaf base—size, length.
10. Leaf apex—form.

In Chart III,[1] Emerson class 15, whose scores are given in detail, shows a somewhat lower individual score than was shown in test 1 by the Jefferson class which was there used for detailed illustration, and also lower than Emerson class 15 had on the preceding test. By com-

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[1] See page 82a.

parison of the final summaries of all classes on the two tests it is seen that there are important differences in the returns. Chart III shows:

a. Points 2, 5, and 7 again elicit the larger number of successful replies in the individual class chart; and point 3, which received a fairly correct reply in test 1, has a higher score, in consequence probably of a somewhat more striking difference in leaf color in test 2, as compared with test 1.

b. The number of y replies by both boys and girls is less than in test 1, the girls' y score still being below that of the boys. The average y score for the whole 148 pupils is 0.6 as compared with 1.1 in test 1.

c. Since the mean + score is 3.5 as compared with 3.7 in test 1, and the y score is 0.6 compared with 1.1, it is evident that the total correct response in test 2 is considerably below test 1, as would be expected from the presumably increased difficulty of the comparisons called for.

d. A study of the summary of individual pupil + scores in each class shows individual scores of wide range, from 0 to 6, with 35 boys and 41 girls below their class mean and 29 boys and 43 girls above their class mean.

Since in tests 1 and 2 certain of the points involved are of such difficulty that but few pupils record the requisite observation, and since on all 10 points there are favorable average responses of almost four points per pupil, it is clear that ability to observe and record observation of the objects has actually been measured by these two tests.

TEST NUMBER 4[1]

Tests 4 and 5 were used for the same purpose as 1 and 2 but were based upon uniformly colored pictures of birds. In tests 1 and 2 the white oak leaf was common to both tests. In 4 and 5 the picture of the kingbird is common to both. In 4 the kingbird is contrasted with the strikingly different picture of the kingfisher, and in 5 the contrast is between the kingbird and the apparently similar but really quite distinctive crested flycatcher.

The blank used in test 4 appears on page 85.

The following are sample answers on test 4:

Jefferson Class No. 18

PUPIL No. 22.

"The breast of the Kingbird is white. The throat is white. The crest has a small red mark on it. The back is brown. The tail is brown & the feathers have white ends. The wings seem to be shorter than those of the Kingfisher. The breast of the Kingfisher has a yellow band across it & brown streaks on either side of the breast. The throat of the Kingfisher has a gray blue band below it. The crest of the Kingfisher is large and upstanding, its color is gray blue. The back is bluish gray. The tail is grayish blue. The bill is longer than that of the Kingbird. The Kingfisher has a white spot near its eye."

Grade 8, Score + 10, y 0, — 2

Emerson Class No. 14.

PUPIL NO. 12.

"Kingbird has a little sploch of orange on his head. The Kingbird

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[1] Test number 3 deals with identification of birds and this test is part of the group to which 6 and 7 belong. Since, however, tests 4 and 5 use named bird pictures, 3 must be given before 4 and 5, but is discussed following 4 and 5 in order that the data may appear with those from 6 and 7 which are of similar nature.

SCIENCE TEST No. 4

Read all of this sheet first.

Directions: In this exercise you are asked to use this sheet and some pictures which are fastened to the lower side of the card which is placed face downward upon your desk. Do not turn the card until told to do so. Fill in the personal data blanks below.

In the following underscore the proper number: This is my 1st, 2d, 3d, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th year in the....................School.

In the following underscore any of the subjects you have studied: I have studied nature study; elementary science, geography, general science, physiology, physiography, botany, zoology, physics, chemistry, agriculture.

Although this is not a test of speed, it is important to record the time of beginning and of closing your work. When told to do so, enter the exact time in hours and minutes in the first time blank; then turn the cards and do the work requested; and then enter the time of finishing.

Time when work is begun......................Grade of pupil..................Boy or girl

Time when work is completed..................Name of pupil............................

Date.................................

The upper picture is of the kingbird; the lower picture is of the kingfisher. In the spaces below state all the differences by means of which you can tell one of these bird pictures from the other.

Kingbird	*Kingfisher*
....	....
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has a very little pompador. The Kingbird has black feathers with white edges. The Kingbird has a white tip to his tail and he has a short bill. The kingfisher has a rough pompador. The kingfisher has blue feathers sploched with white, & has brown under his wings. The kingfisher has a little white spot in front of his eyes and has a long bill. He has a little blue collar across his white breast & just below that has a little yellow collar."

Grade 8, Score + 8, y 2, — 2

Pupil No. 13.

"The kingbird has a little bit of brown on his head and the kingfisher has not. Its tail is gray and the tips of the feathers in the tail are white. It has a white breast. The kingfisher is kind of blueish in color and has a longer bill and it stays around water most of the time. Its neck is white, its head is blue gray, its breast is white, broun and yellow its tail is blue and white and its claws are longer and thiner than a kingbird."

Grade 8, Score + 6, y 0, — 6

Froebel Class No. 45.

Pupil No. 9.

"The kingfisher is light blue and has black and white spots on its back. It has black spots on back and wing and white on its tail and a very little on its wings. The breast is white with a yellow streak across and under the wings connecting with the yellow streaks are two crimson streaks. There is a blue ring around its neck dotted with black the rest of its neck is white up to the head and the head is a light blue with a tuft on it. The Kingfisher has broun eye a very long bill and has a white splash in front of its eye. It has broun feet. The Kingbird is a grayish dull broun coller nearly black and the wings have white streak around them. It has a broad tail, with a white loop on each feather and a clear wite breast it has a dark head like its back and wings with read on top. it has not a long bill."

Grade 8, Score + 10, y 0, — 2

Pupil No. 17.

"The kingbird is dark & has a orange spot on its head. It has a white border on it tail. The kingbird has a smaller bill and has not a big croun of feathers like the kingfisher. The kingbird has a white breast. The kingbird has very many feathers on it head has a long bill. Has a blue rim around the neck. And has a white spot by his eye. Its color is a light blue just like dots. Has red feathers under it wings and some of it is shown."

Grade 8, Score + 7, y 2, — 3

Beveridge Class No. 12.

Pupil No. 2.

"The Kingbird is broun, and has little orage on its head tip of feathers are white and has a shorter bill than the Kingfisher. The Kingbird has blue eyes and the Kingfisher hasn't. and has a white breast all over and the Kingfisher hasn't and it looks mild. The Kingfisher looks skared and has a lite blue back and the neck is white and has purpil eyes hair on its head stands straight up. its breast is yellow orange· white has little black spots all over its back and has a long bill."

Grade 7, Score + 8, y 1, — 3

The points upon which the scores were determined in test 4 are as follows:

		KINGFISHER	KINGBIRD
1.	Beak	long, thick, sharp	short, sharp
2.	Crown	blue gray	orange or reddish
3.	Crest	heavy, stiff feathers top of head	smaller crest.
4.	Eye	white	red
5.	Spot	white spot at beak	none
6.	Throat	white	white
7.	Breast	blue-gray with dark band	light gray
8.	Sides	reddish or chestnut	plain brownish color
9.	Wings	heavy, stiff, strong banded	light
10.	Tail	short, banded, stubby	tip white
11.	Back		dark gray with white streaks
12.	Feet	strong, heavy	slender, clasping
13.	Miscellaneous—size, relation of form and color to habits, and other occasional observations not common enough to classify under separate points, but too important to be ignored.		

In reading scores based upon 12 points instead of 10, as in tests 1 and 2, care must be used to avoid thinking of a score in this test as strictly comparable with those previously discussed.

In Chart IV[1] the Beveridge seventh grade class is used for individual pupil illustrations and below it there appear the summaries and the distributions of individual class scores. The chart shows:

a. Certain points are observed and recorded by most of the pupils. Thus 29 of the 31 Beveridge pupils record the distinctive characters of the crowns of the two birds, and 139 of the total 172 pupils make these distinctions. On point 1, the beak, 21 of the 31 Beveridge pupils give satisfactory replies, as do 145 of the total 172. Similarly, satisfactory replies are given on points 1, 2, 3, 7, and 10.

b. Points 4 and 12 are recorded only by most careful observers. For example, pupil number 34, Beveridge class, one of the four high pupils in the class, is the only one of the whole Beveridge class to respond correctly on point 12.

c. The boys of the Beveridge as well as in all the schools make scores as good as those of the girls. The girls have the widest range of scores.

d. The individual class distributions show a range in scores from 0 to 10, with 30 boys and 47 girls below their class mean, and 46 boys and 47 girls above their class mean.

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[1] See page 88a.

Pupil's	Time for An-	Point 1	Point 2	Point 3	Point 4	Point 5	Poi

TEST NUMBER 5

Test number 5 is associated with test 4, in the same way that test 2 was associated with test 1. The two bird pictures chosen as the objective materials for the test include one of those used in test 4, and another apparently similar to it, but in reality having quite distinctive characteristics. The blank for the test is shown on page 90.

The following are sample answers on test 5:

Jefferson Class No. 18.

PUPIL No. 1.

"The Kingbird has a black back and tail the tail has a little white ridge on the bottom of it. His breast and neck is white it also has a little orange spot on the top of his head. It has not got wiskers. The flycatcher has a grey back. Its wings are white yellow and red its neck is white like the Kingbirds but its breast is gray and its stomach yellow. It has a top notch and a crooked end on its back. It has wiskers. Its legs are longer than the Kingbirds."

Grade 8, Score + 10, y 0, — 1

Emerson Class No. 14.

PUPIL No. 41.

"The Kingbird has a pointed beak and an orange spot above his eyes. He has a white breast and a white strip on his tail. His back is brownish black. The Flycatcher has a little crown on his head and a gray neck. His breast is yellow and some of his feathers are a real dark red, part of them are grayish brown and edged with white. His beak is sort of turned down at the end and he has a small beard."

Grade 8, Score + 8, y 0, — 3

SCIENCE TEST No. 5

Read all of this sheet first.

Directions: In this exercise you are asked to use this sheet and some pictures which are fastened to the lower side of the card which is placed face downward upon your desk. Do not turn the card until told to do so. Fill in the personal data blanks below.

In the following underscore the proper number: This is my 1st, 2d, 3d, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th year in the....................School.

In the following underscore any of the subjects which you have studied: I have studied nature study, elementary science, geography, general science, physiology, physiography, botany, zoology, physics, chemistry, agriculture.

Although this is not a test of speed, it is important to record the time of beginning and of closing your work. When told to do so, enter the exact time in hours and minutes in the first time blank; then do the work requested; and then enter the time of finishing.

Time when work is begun....................Grade of pupil....................Boy or girl

Time when work is completed....................Name of pupil....................

Date....................................

The upper picture is of the kingbird, the lower picture is of the flycatcher. In the spaces below state all the differences by means of which you can tell one of these bird pictures from the other.

Kingbird	*Flycatcher*
....	....
....	....
....	....
....	....
....	....
....	....
....	....
....	....
....	....
....	....
....	....
....	....
....	....
....	....

Froebel Class No. 46.

Pupil No. 28.

"The Kingbird has red feathers on his forehead. The Kingbird's tail feathers are black with white tips. He has a white throat and a grayish breast. His wing feathers are black and white. The bill is straight and long. Claws are shorter than the Flycatchers claws. The eyes are a yellowish color. The Flycatcher has a grayish color feathers on his forehead. The tail feathers are part brownish red and part brown. The Flycatcher has a grayish throat and a yellow breast. His wing feathers are yellow, gray, red and brown and white. The bill is long and hooked. The eyes are red."

Grade 8, Score + 8, y 1, — 2

Beveridge Class No. 12.

Pupil No. 6.

"The king bird has a redish colored topknot it has a whitish gray breast and, its back is of a carterroy color with little white strekes at the tip the feathers and the tip of tail is a purer white than breast and has a kind of heavy bill. The flycatcher has a greenish colored topknot its cheast is of a grayish black and its breast is of a yellow color and the back of its kneck is of a grayish black to and its wings is of a greenish color with white tips and at the bottom is a redish color its tail is a dark black grayish color with redish color on each side and at the end of the bill is a hook like end."

Grade 7, Score + 8, y 0, — 3

The points used in scoring test 5, omitting "whiskers," are the same as those used in scoring test 4. In Chart V[1] Emerson class 14 is used for detailed illustration, and summaries of other classes are also given. Chart V shows:

a. Certain points are observed by nearly all pupils, and the color of the bird's breast is observed and recorded by all pupils in Emerson class 14 and by 163 of the total 168 pupils who took this test. Tail markings are observed by all but 3 Emerson class 14 pupils and by 159 of the total 168. The distinctive crown markings are recorded by 33 of the 39 Emerson class 14 pupils and by 152 of the total 168 pupils.

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[1] See page 92a.

b. Only 16 of the 168 pupils record observations regarding differences in the form of the feet of the two birds.

c. The very low score for "y" or indefinite records is notable, since apparently a point when observed at all could easily be formulated correctly and clearly.

d. Pupils who observe and record the most difficult points, such as numbers 4, 5, and 6, are generally pupils who make a high score on other points, indicating that the less frequently answered points are really the more severe tests and thus serve to differentiate the better from poorer pupils.

e. In the summary of individual pupil + scores in each class, it is noted that the girls slightly excel the boys, though both boys and girls make favorable records.

SUMMARY OF TESTS ON OBSERVATION AND DISCRIMINATION OF LIKENESSES AND DIFFERENCES

Tests 1, 2, 4, and 5 all bear directly upon ability in observation and discrimination. Study of records from these tests shows a considerable number of satisfactory responses, which are fairly uniform in their nature so far as facts reported are concerned. A comparison of the mean results of the four tests is made in the following table:

Sc

Pupil's No.	Time for Answer (Min.)	Point 1 Beak	Point 2 Crown	Point 3 Crest	Point 4 Whiskers
Emerson, Class 14, Boys					
1	8	+	—	—	+
2					
3	6	—	+	+	+
4	6	+	+	+	—
5	2	+	+	—	+
6	6	+	+	—	—
7	5	—	+	—	—
8	4	—	+	—	—
9	6	+	+	+	—
10	7	—	+	+	—
11	6	—	y	+	—
12	8	+	+	+	+
13	6	+	+	y	+
14	5	—	+	—	—
15	5	+	+	—	—
16	7	+	+	—	+
17	7	+	+	—	—
Number of + answers		10	14	6	6
Number of y answers		0	1	1	0

SUMMARY OF TESTS 1, 2, 4, AND 5

	NO. OF PUPILS	NO. OF POINTS IN TEST	MEAN SCORES		
			+	y	—
Test 1 (Elm—White Oak leaves).....	150	10	3.7	1.1	5.1
Test 2 (White Oak—Red Oak leaves).	148	10	3.5	0.6	5.7
Test 4 (Kingbird–Kingfisher pictures)	172	12	5.4	1.0	5.5
Test 5 (Kingbird–Flycatcher pictures)	168	11	5.8	0.4	4.6

These mean scores are made up of so many elements that the figures cannot be interpreted as being anything more than a general statement, but they show possession of the types of abilities in question so far as they relate to the particular objects used in the tests.

From the charts which give the summaries of the six classes on each of the four tests the girls are seen to score a little higher than the boys in most cases. The pupils in the Beveridge seventh grade class and the Jefferson eighth grade class reported that they have had no considerable instruction in science. Notwithstanding these facts the Beveridge seventh grade pupils are close to the other classes in their scores on two of the tests and below them on two others. The Jefferson class leads in its average score on three of the four tests and is second on the other one. Undoubtedly elements other than previous training in science enter into the ability of the Jefferson pupils as well as others who took the tests.

TEST NUMBER 3[1]

Tests numbers 3, 6, and 7 were planned to give a check on pupils' abilities to recall past experiences in nature studies or elementary science and to use these experiences in similar or new situations. Practically all elementary instruction in science deals at some time with identification of common birds, with the nesting habits of birds, and with the life habits of some of the more common insects.

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[1] See note on page 84.

In test 3 eight pictures of birds (instead of 10 as indicated on the test blank) were used. These pictures, which are uniform and of the best colored prints available, are of the robin, flicker, bluejay, meadowlark, kingfisher, bluebird, kingbird, oriole. All these birds are found at some time of the year in and about the city of Gary. The test blank is given on page 95.

Since this test called only for the common names of the eight birds as shown in the pictures, no sample answers need be presented. It should be said that no pupil named all the birds correctly, and that names of several birds other than those whose pictures were shown were given.

In Chart VI[1] Emerson class 14 is selected for detailed study because of the fact that the scores of the boys in this grade are so strikingly different from those of the girls. It is evident that most scores were reduced by the fact that the pupils called the flicker a woodpecker, a not wholly incorrect name since it is sometimes improperly so called. Few of the pupils knew the kingbird or the meadowlark.

The mean score for the boys is + 4.4, y 1.0, — 2.5;

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[1] See page 94a.

Pupil's No.	Time for Answer (min.)	Point 1 Robin	Point 2 Flicker[1]
Emerson, Class 14, Boys			
1	5	+	y
2	5	+	y
3	6	—	y
4	6	+	y
5	4	+	y
6			
7	4	+	y

SCIENCE TEST No. 3

Read all of this sheet first.

Directions: In this exercise you are asked to use this sheet and some pictures which are fastened to the lower side of the card which is placed face downward on your desk. Do not turn the card until told to do so. Fill in the personal data blanks below.

In the following underscore the proper number: This is my 1st, 2d, 3d, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th year in the....................School.

In the following underscore any of the subjects you have studied: I have studied nature study, elementary science, geography, general science, physiology, physiography, botany, zoology, physics, chemistry, agriculture.

Although this is not a test of speed, it is important to record the time of beginning and of closing your work. When told to do so, enter the exact time in hours and minutes in the first time blank; then turn the cards and do the work requested; and then enter the time of finishing.

Time when work is begun....................Grade of pupil....................Boy or girl

Time when work is completed....................Name of pupil....................

Date....................

With the pictures of birds before you, write the common name of each bird in the order in which the birds are numbered. When two or more birds are shown in the same group, they are the male and the female, or young birds, of the same kind.

Names of Birds *Answers to Questions*

1. ....Have you seen this bird?....................
Have you used it in class work?....................

2. ....Have you seen this bird?....................
Have you used it in class work?....................

3. ....Have you seen this bird?....................
Have you used it in class work?....................

4. ....Have you seen this bird?....................
Have you used it in class work?....................

5. ....Have you seen this bird?....................
Have you used it in class work?....................

6. ....Have you seen this bird?....................
Have you used it in class work?....................

7. ....Have you seen this bird?....................
Have you used it in class work?....................

8. ....Have you seen this bird?....................
Have you used it in class work?....................

9. ....Have you seen this bird?....................
Have you used it in class work?....................

10. ....Have you seen this bird?....................
Have you used it in class work?....................

and for the girls the mean is + 2.8, y 1.0, — 4.0. In this class 4 boys and 14 girls are below the mean; while 12 boys and 8 girls are above the mean. Of all the classes 26 boys and 46 girls are below their class mean, and 42 boys and 39 girls are above their class mean. The boys excel the girls in this test in all but one class, Froebel 45, and equal the girls in that class.

As shown in the individual scores of Emerson class 14, most pupils recalled having seen the birds whose pictures were used, and a good many recalled having used the birds in class studies. Since this test was based upon ability to recall names of things seen, it is important to associate the test with 6 and 7, in which processes, experience or uses of information are also called for.

TEST NUMBER 6

In test 6 ten common birds are named and the pupils are asked to select any four from this group and to answer questions about them. Four questions were asked about each bird for the purpose of discovering the extent to which pupils are able to recall the nesting habits of birds.

The test blank is on page 97.

The following are sample answers on test 6:

Jefferson Class No. 18

PUPIL No. 3.

"Robin. (1) trees (2) straw, feathers, grass. (3) early spring in April. (4) worms & insects. Cat bird (1) swamps. (2) grass (3) June (4) insects. Eng. sparrow (1) house eves. (2)

SCIENCE TEST No. 6

Read all of this sheet first.

Directions: **In this exercise you are asked to use this sheet, a list of birds; and some questions given below. Fill in the personal data blanks below.**

In the following underscore the proper number. This is my 1st, 2d, 3d, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th year in the....................School.

In the following underscore any of the subjects which you have studied: I have studied nature study, elementary science, geography, general science, physiology, physiography, botany, zoology, physics, chemistry, agriculture.

Although this is not a test of speed, it is important to record the time of beginning and of closing your work. When told to do so, enter the time in hours and minutes in the first time blank; then do the work requested; and then enter the time of finishing.

Time when work is begun..................Grade of pupil..................Boy or girl
Time when work is completed..................Name of pupil..........................
Date....................................

Following are the names of ten birds: robin; red-headed woodpecker; flicker; cat-bird; crow; bluebird; brown thrasher; English sparrow; wren; oriole.

In the left-hand column below, place the names of any four of these birds, and in the remaining columns answer the four questions asked about each of the four birds.

	Name of Bird Selected	*In What Kinds of Places Does It Build Its Nest?*	*Of What Material Does It Build Its Nest?*	*At What Time of Year Does It Build Its Nest?*	*Upon What Does It Feed Its Young?*
1					
2					
3					
4					

straw, string feathers. (3) early spring (4) worms. woodpecker (1) tree hollows. (2) grass, string (3) Late spring (4) insects, worms."

Grade 8, Score + 8, y 8, — o

PUPIL No. 4.

"Eng. sparrow (1) In trees or around houses.

(2) sticks straw cotton, hair. (3) May, (4) worms bugs etc. Oriole. (1) on trees in country (2) hair cotton straw. (3) spring. (4) worms, bugs, Red headed woodpecker (1) in hollow trees. (2) wood, hollow logs. (3) Spring (4) worms. Robin (1) In trees sometimes around houses. (2) straw hair cotton sticks. (3) beginning of spring. (4) worm."

Grade 8, Score + 9, y 7, — o

Emerson Class No. 14.

PUPIL No. 10.

"Woodpecker (1) In hollow Trees. (2) feathers,

String, (3) Spring (4) worms, Bread crums. Eng. Sparrow. (1) In tree crotches and eve spouts (2) Straw mud, String, Silk threads, Feathers (3) Latter part of March or first of April. (4) Worms Bugs, Bread crums. Oriole. almost generally on a horizontal limb. (2) Feathers, straw, thread, (3) about the middle of June. (4) worms.

Robin: (1) on tree limbs and in crotches. (2) Feathers, Mud, thread, (3) First of April, (4) Worms, bread crums."

Grade 8, Score + 14, y 2, — o

PUPIL No. 19.

"Robin: (1) in warm places, generally in a tree.

(2) straw, string, cotton, feathers, mud, (3) about the first of May, (4) worms.

Eng. sparrow: (1) in a moderate climate and also in a tree. (2) strings, straw, feathers, mud. (3) April and Sept. (4) crums and such things. Crow. (1) in cornfield or near one (2) twigs and corn schucks (3) when the corn begins to grow and rippen. (4) worms and corn."

Grade 8, Score + 9, y 3, — 4

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In test 6 it was not expected that pupils would give detailed descriptions of the materials of which nests were constructed, nor that they would give long lists of materials which are fed to the young birds. Any definite and correct statement is accepted as worthy of a full score even though it might have been possible to make a more detailed statement.

In Chart VII[1] Froebel class 45 is used as a sample illustration of detailed scoring. Near the right hand end of the chart the names of all the birds are given and the particular four selected by each pupil for his test are indicated by check marks. The first group of points 1, 2, 3, 4 provides for answers upon all four questions for the first bird, the second 1, 2, 3, 4 for the second bird, etc., until all 16 points are provided for. Each bird in the list was chosen, but those chiefly chosen in all classes were the robin, red-headed woodpecker, and the English sparrow, though others, such as the crow, bluebird, oriole, and wren were chosen by almost one-third of all pupils. This shows a fairly wide range of information about most of the birds listed.

In Froebel class 45, used for detailed individual illustration, the boys' mean score is + 7.1, y 8.0, — 0.8, with a low score of 3 and a high score of 13. The girls have a mean score of + 7.5, y 7.1, — 1.2, with a low score of 5 and a high score of 12. The summary of individual pupil + scores in each class shows a range from 0 to 14, there being 27 boys and 53 girls below the class mean, and 43 boys and 38 girls above the class mean.

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[1] See page 98a.

The four questions asked about each bird called for somewhat different types of information. In consideration of this fact it is notable that of a total of 164 pupils who took this test no question received less than 31 satisfactory replies and 109 satisfactory replies were given to one question and 91 to another.

TEST NUMBER 7

In this test, which is similar in purpose to number 6, the names of ten common insects are given. From this list pupils are asked to select four, about each of which they are to answer four questions. The test blank is on page 101.

The following are sample answers on test 7:

Jefferson Class No. 18.

PUPIL No. 1.

"Housefly. (1) In houses, garbage cans, dirty places and sick people. (2) Like the older only smaller (3) Garbage and dirty stuff. (4) It goes around sick people and gets their decease germs and puts them on well people and babys and food. Mosquito. (1) In woods or in houses. (2) At first it has only head and tail and swims around on still water. (4) it stings and makes inflamed itching spots on a persons body. Black ant. (1) in and on the ground around houses. (2) It is a larva when it hatches it turns into an ant. (4) It spoils the grass.
Wasp: (1) in a nest (2) something like a antworm (3) Honey. (4) It makes honey but it is not nice to be stung by one."

Grade 8, Score + 4, y 10, — 2

SCIENCE TEST No. 7

Read all of this sheet first.

Directions: In this exercise you are asked to use this sheet of paper, a list of insects, and some questions given below. Fill in the personal data blank below.

In the following underscore the proper number: This is my 1st, 2d, 3d, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th year in the..................School.

In the following underscore any of the subjects you have studied: I have studied nature study, elementary science, geography, general science, physiology, physiography, botany, zoology, physics, chemistry, agriculture.

Although this is not a test of speed, it is important to record the time of beginning and of closing your work. When told to do so, enter the exact time in hours and minutes in the first time blank; then do the work requested; and then enter the time of finishing.

Time when work is begun.....................Grade of pupil..................Boy or girl
Time when work is completed....................Name of pupil...........................
Date.....................................

Following are the names of ten insects: housefly; mosquito; wasp; honeybee; clothes moth; ladybug beetle; cabbage butterfly; cecropia moth; black ant, bumblebee.

In the left-hand column below place the names of any four of these insects, and in the remaining columns answer the four questions about each of the four insects.

	Name of Insect Selected	*In What Kinds of Places Does This Insect Live?*	*What Is the Appearance of the Young of This Insect?*	*Upon What Does the Young of This Insect Live?*	*What Harm or Good Is Done by This Insect or Its Young?*
1					
2					
3					
4					

PUPIL No. 3.

"Housefly: (1) In craks of the house. (2) Like a little worm. (3) scraps of meat or any kind of flesh. (4) They carry desease.
Black ant. (1) in the ground. (1) like the old one excepting the wings. (3) bread or any kind of other insects. (4) they sometimes crawl into the house and get into the food.
Mosquito. (1) rain barrels or swamps. (2) like real tiny polly-wags. (3) the same thing that the fish does. (4) it bites the people or stings them.
Honeybee: (1) hives or in hollow trees. (2) same as old one. (3) Honey. (4) The honey of the bee is used as a food."

Grade 8, Score + 3, y 12, — 1

Emerson Class No. 14.

PUPIL No. 10.

"Housefly: (1) Around manure piles, garbage cans and all filthy places. (2) Like a small worm. (3) Upon garbage, manure or whatever is near. (4) Carries all kinds of deadly deseases. Black ant: (1) mounds in the ground that are made of sand. (2) Like old one only much smaller. (3) Pieces of Bread. (4) Carries deseases.
Mosquito: (1) around swamps, lakes, rivers etc. (2) Like old one only smaller. (3) Upon manure (4) They carry yellow fever and all other deseases.
Honeybee: (1) In trees tops of old barns and sometimes they are housed by farmers so they may get the honey easier. (2) Like old ones only smaller. (3) On honey. (4) Make Honey."

Grade 8, Score + 6, y 6, — 4

Beveridge Class No. 12.

PUPIL No. 6.

"*Mosquito:* (1) in a swampy place. (2) like a little fish-worm but we call them wigglers. (3) On blood. (4) carrys deseases.
Honeybee: (1) In a hive. (2) Like a little white and of a bean (3) They are fed polven or be bread. (4) They make honey for use to eat.
Black ant (1) In a hole in the ground which we call ant holes. (2)

Like the end of a bean after it has been cook. (3) On crumbs sugar and etc. (4) They get in your vegetables.
Housefly: (1) Where it is all dirty. (3) On the leavings of the dinner table. (4) They carry all kinds of deceases."
Grade 7, Score + 6, y 7, — 3

A study of the Jefferson sample individual class scores given in Chart VIII[1] shows that the element of indefiniteness or failure is much more common in the results of this test than in other tests. Out of a possible score of 16, the mean class score is 4.1, y 6.2, — 5.6. The summaries of scores on each point given for all other classes shows a similar proportion of indefiniteness and failure in other classes. In but one point, the habitat of insects, did the 166 pupils make a score above 100, this being on the insect first chosen. The summary of individual pupil + scores in each class shows a range in scores from 0 to 12, with 35 boys and 52 girls below the class mean, and 40 boys and 39 girls above the class mean. The insects chiefly chosen for discussion were the housefly and mosquito.

SUMMARY OF RESULTS IN TESTS 3, 6, AND 7

When results from tests 3, 6, and 7 dealing with recollection and use of previous experiences are compared with tests 1, 2, 4, and 5, which deal with observation and discrimination, it appears that pupils in their responses to these tests make less satisfactory responses on the second group than on the first. The amount of response is large enough, however, to show a considerable knowledge of the questions asked in these particular tests.

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[1] See page 102a.

TEST NUMBER 8

Tests 8 and 9 were planned to discover the extent of abilities in interpretation of phenomena which change under the observation of the pupils. The test blank and the accompanying photograph[1] of the apparatus used in test 8 show that a large candle (or three candles) is lighted and placed in the glass faced box, which is then closed with the exception of two openings—one directly above the flame and the other in the end of the box opposite the flame. A piece of punk or bundle of Chinese incense sticks is lighted and placed near the end opening in the box. Part of the smoke from the punk moves first through the end opening of the box into the box, then through the box and out at the opening above the flame. The pupils are asked to state what was done in the performance of the experiment, what movements of smoke occurred, and to explain what caused the smoke to move through the box. The test blank is on page 105.

The following are sample answers on test 8:

Jefferson Class No. 18.

PUPIL No. 8.

"(1) First we lighted the punk or smoking coal and placed it by the hole in the side of the box. Then we lighted the candals and closed the box. we put the glass tube over the chimney. (2) Some of the smoke that the smoking coal made rushed into the glass box while the other part rushed to the ceiling. The smoke that the candals made went through the chimney at the top. (3) When

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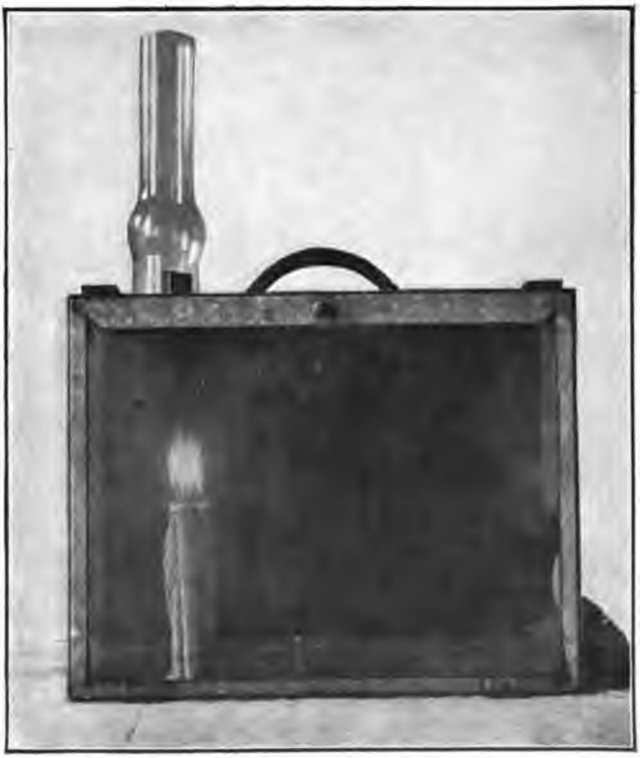
[1] See Figure 4, opposite this page.

FIGURE 4

THE APPARATUS USED IN TEST 8



SCIENCE TEST No. 8

Read all of this sheet first.

Directions: In this exercise you are asked to use this sheet and an experiment which will be shown you. Fill in the personal data blanks below

In the following underscore the proper number: This is my 1st, 2d, 3d, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th year in....................School.

In the following underscore any of the subjects you have studied: I have studied nature study, elementary science, geography, general science, physiology, physiography, botany, zoology, physics, chemistry, agriculture.

Although this is not a test of speed, it is important to record the time of beginning and of closing your work. After the experiment has been shown you, and when told to do so, enter the exact time in hours and minutes in the first time blank; then do the work requested; and then enter the time of finishing.

Time when work is begun....................Grade of pupil..................Boy or girl

Time when work is completed..................Name of pupil..........................

Date................................

In the experiment we shall use a glass-faced box, a lamp flue, a lighted candle, and a smoking piece of punk. After carefully observing what happens, you are asked to make three statements: What was done? What movements of smoke occurred? What made the smoke move as it did? Answer the questions below.

1. What was done?..

....

....

....

....

2. What movements of smoke occurred?..

....

....

....

....

3. What made part of the smoke move through the box?..........................

....

....

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....

the box was closed the candals heated the air causing it to expand and grow lighter and thus rising to the ceiling carrying the hot smoke with it. When the air in the box rose to the ceiling through the chimney the fresh or cold air on the outside of the box rushed in through the hole in the side of the box to take the place of the hot air. Thus taking the smoke from the punk with it. Winds are caused by the same principal."

Grade 8, Score + 17, y 0, — 1

Emerson Class No. 14.

PUPIL No. 8.

"(1) We lit the smoking coal and then the candles and closed the box. and put a glass chimney on the opening on top. (2) The smoke from the punk was put at the opening and the smoke went in the box through the opening. (3) The air was use up by the candle and the smoke took the place of it then it when to the top and new air took it place that cause a suchtion."

Grade 8, Score + 11, y 5, — 2

Froebel Class No. 45.

PUPIL No. 1.

"first he took a lamp chimney and put it on the top of the box. Then he lit the punk and let the smoke go in through an empty space. Then he lit the three candles and closed the box. (2) The smoke went towards the burning light. It went eastward after it reach the burning candle it went out of the lamp chimney. (3) the burning candles make the smoke draw nearer to the flame because a fire draws smoke because smoke is light & heat makes smoke follow it."

Grade 8, Score + 12, y 3, — 3

Froebel Class No. 46.

PUPIL No. 18.

"(1) Three candles were lighted in the box and some lighted punk was placed outside the box but near the opening at the side. (2) At first the smoke from the punk went up but when the candles were lighted the smoke passed through the opening into the glass box. Some of the smoke would go up (3) The candles heated the air and

made it go up. There was then room at the bottom of the box so the smoke went through the opening."

Grade 8, Score + 11, y 0, — 7

The points on which test 8 was scored are given below. Since it was desired to fix attention definitely upon the different parts of the apparatus so that the further statement of what occurred and the interpretation of what occurred might be as definite as possible, the pupils were asked in Part I to state what was done in the performance of the experiment, in Part II to state what occurred, and in Part III to explain results. The records were thus divided into three parts in order to assist in securing definiteness in responses. If statements which belong under one part appeared under another part they were accepted. The list of points used in scoring was made up not only from the points which were expected in a complete answer, but after a careful study of the responses actually given by pupils. There is evidently wide range in the relative value of the different points used in the scoring. Also there is some overlapping of points, as, for example, in point 18, the idea of which would often be included elsewhere; but this was distinctly mentioned in a few cases and was therefore included as one of the points scored.

POINTS CONSIDERED IN GRADING TEST NO. 8

Part I. What was done

1. Candles were lighted.
2. Candles were placed in the box.

3. Door of box was closed.
4. Punk was lighted.
5. Punk was placed outside, in front of lower hole.
6. Chimney was placed on outside, above candles.

Part II. What happened

7. A part of the smoke went around the box into the room.
8. A part of the smoke went into the box through the hole.
9. This passed through (or across) the box.
10. A part of this smoke passed up the chimney.
11. The smoke from the candles passed up the chimney.

Part III. Explanation of Results

12. Oxygen of the air caused candles to burn.
13. The air above the flame became heated.
14. Air, when heated, expands and becomes lighter.
15. The lighter air rises.
16. Cooler air comes in through the hole at the bottom, crowds the lighter air upward, and thus takes the place of the lighter air.
17. With this current the smoke from the punk is carried.
18. The smoke becomes heated and most of it rises through the chimney.

The answer "The draft caused the smoke to move in" has been credited under point 16.

The individual scores of Froebel class 46 given in Chart IX[1] show that one or more pupils responded on each of the eighteen points, though on point 14 there is no + score and but one y score. This shows that, while point 14 is important as a fact in interpretation of occurrences in the test, it is practically negative so far as this particular class is concerned. This is almost equally true of points 11, 12, 15, and 18. A study of the summaries of other classes presented in the lower part of Chart IX shows similarly low returns in other classes on points 14, 15, and 18. In the individual class chart record it is interesting to note that, of the 20 pupils present when this test was given, all have + scores on point 1, 19 have + scores on points 2 and 8, and 18 have + scores on points 4 and 5. The summaries of all classes show relatively high returns on points 1, 2, 4, 5, and 8, there being 160 or more scores on each of these points from the 168 pupils.

The individual pupil summaries for Froebel class 46 show pupil scores ranging from + 3, y 6, — 9 and + 4, y 2, — 12, to + 11, y 1, — 6 and + 11, y 0, — 7. The class mean score is + 8.1, y 1.6, — 8.2. The summary of individual pupil + scores in each class shows a range in scores from 3 to 17, there being 41 boys and 45 girls below their class mean and 36 boys and 46 girls above their class mean.

The Jefferson class has a strikingly high score, a class mean of + 10.2, y 0.9, — 6.8. This class, as previously indicated, has a much more regular school program as a whole, without any of the elementary science courses which are given in the grades by high school teachers in the Froebel and Emerson schools.

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[1] See page 108a.

Referring again to the summaries of scores of all the classes, it is seen that the high scores, as would be expected, are chiefly on the points under Part I, which called for statement of what was done. Good scores also appear under Part II, which called for statement of what occurred, but low scores appear in Part III where interpretation was called for.

TEST NUMBER 9

This test,[1] as in test 8, is divided into three parts, but the different parts are not comparable to those of 8, since in 9, each part calls for interpretation of occurrences, as is indicated in the test blank on page 111.

The following are sample answers on test 9:

Jefferson Class No. 18.

PUPIL No. 23.

"(1) The air could get out and let the water in. (2) The cork would not let the air out. (3) The cork let some of the air out—and the water rushed in to take its place."

Grade 8, Score + 6, y 2, — 5

PUPIL No. 35.

"(1) There was an open space in the bottom of the funnel. (2) The cork prevented the air from coming out. (3) Only a little air could come out at a time and the water could run in only as the air came out."

Grade 8, Score + 5, y 0, — 8

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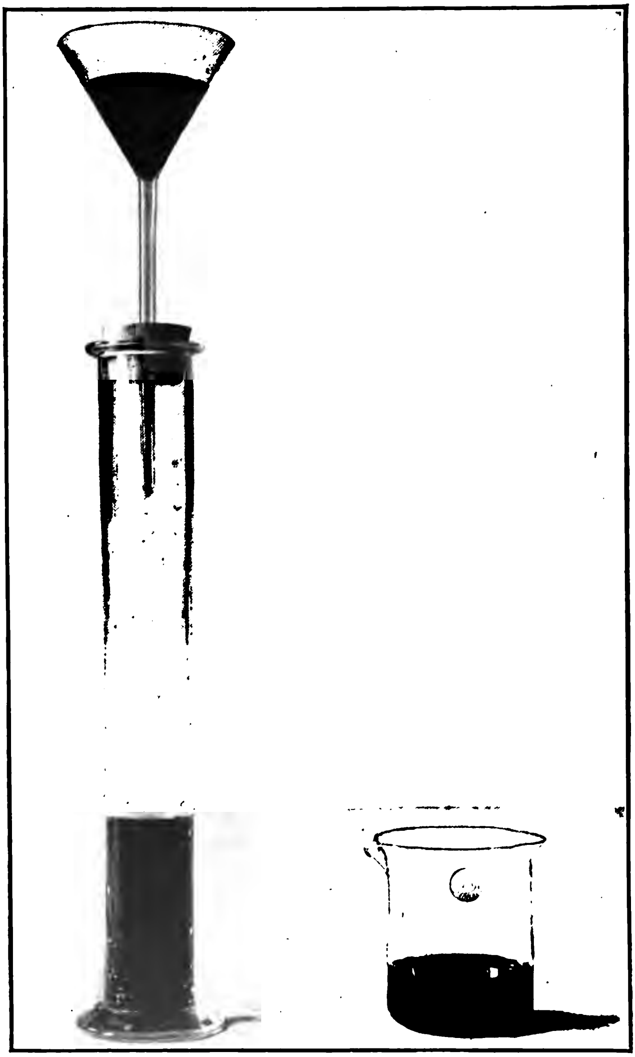
[1] See Figure 5, opposite this page.

FIGURE 5

THE APPARATUS USED IN TEST 9



SCIENCE TEST No. 9

Read all of this sheet first.

Directions: **In this exercise you are asked to use this sheet and an experiment which will be shown you. Fill in the personal data blanks below.**

In the following underscore the proper number: This is my 1st, 2d, 3d, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th year in the....................School.

In the following underscore any of the subjects you have studied: I have studied nature study, elementary science, geography, general science, physiology, physiography, botany, zoology, physics, chemistry, agriculture.

Although this is not a test of speed, it is important to record the time of beginning and of closing your work. After the experiment has been shown you, and when told to do so, enter the exact time in hours and minutes in the first time blank; then do the work requested; and then enter the time of finishing.

Time when work is begun.....................**Grade of pupil**..................**Boy or girl**

Time when work is completed..................**Name of pupil**..........................

Date..................................

In the experiment we shall use a tall glass jar, a funnel, a glass of water, and a rubber stopper. We shall perform the experiment in three parts, after which you are to answer the questions below:

1. When the water was first poured into the funnel, why did it flow down into the tall glass jar?...

....

....

....

2. After the funnel was inserted into the cork, the cork placed in the jar, and the water poured into the funnel, why did not the water flow down into the tall glass jar?......................

....

....

....

3. When the cork was slightly withdrawn the water began running down and continued running, then stopping, then running and stopping in the same way until all the water had run down. What caused the water to act in this way?.......................................

....

....

....

Emerson Class No. 14.

PUPIL No. 41.

"The air was pushed out, and the water took its place. (2) The air could not get out, and it went up into the funnel the water could not get past it. (3) The air could get out a little and did so."

Grade 8, Score + 7, y 1, — 5

Froebel Class No. 46.

PUPIL No. 5.

"(1) The funnel wasn't tight enough to the glass jar so the water pushed the air out and flowed into the jar. (2) The pressure of the water was not strong enough to push the air out. (3) The air pushed its way out through the funnell little by little so the water began to flow down just a little each time the air escaped."

Grade 8, Score + 7, y 1, — 5

PUPIL No. 14.

"(1) The air that was in the jar could get out and gave the water chance to flow in. (2) The water did not flow into the jar because it was stoped up by the air that was in the jar, because it couldn't get out and the water did not get room to flow in. (3) The air could get out little by little."

Grade 8, Score + 6, y 1, — 6

The list of points on which pupils are scored is as follows:

POINTS CONSIDERED IN GRADING TEST NO. 9

Part I

1. "Gravity" or "weight of water" causes it to run down the tube.
2. Pressure of water downward is greater than that of air upward, or pressure of water and air downward is greater than that of air upward.

3. The air is forced out of the jar by the water.
4. Some relation to air—miscellaneous answers in addition to above.

Part II

5. The jar is already filled with air.
6. The stopper prevents this air from escaping.
7. The upward pressure is sufficient to hold up the water.
8. Two things cannot occupy the same space at the same time, or, the water could not enter because it could not force the air out.

Part III

9. The inside air pressure is reduced.
10. A little water enters.
11. The force of the entering water compresses the air in the flask so that the pressure inside and outside are again unequal.
12. A few bubbles of air escape until pressure is reduced.
13. More water enters, and the process is repeated until the water has all entered.

In Chart X[1] the individual class records of Emerson class 15 are presented as illustrations. There is a wide range in the value of different points as is shown by the fact that on point 4, 28 of the 35 pupils who took this test have + scores; while on point 11 no pupil in this class made either a + or a y score. Also it is shown by the totals from all classes at the bottom of the chart that no one made a + score on points 11 or 12, and only 13 and 12 made y scores. Notwithstanding the low return on these points, it still seems wise to retain them in scoring since the ideas of these points are involved in a thorough explanation of what occurred in the experiment.

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[1] See page 114a.

The scores of individual pupils in Emerson class 15 range from that of pupil number 29 who gave no answer of merit, to pupils numbered 6 and 7 whose scores respectively are + 7, y 0, — 6, and + 7, y 2, — 4. Only 9 of the 35 pupils made scores of + 5 and more, and the mean score for the whole class is + 2.2, y 0.4, — 10.2.

However, the boys made markedly better scores than the girls, only 2 of the 18 girls making scores better than + 1. A study of the summaries of all classes shows that the class average scores range from the Beveridge seventh grade, which, as stated, had received no science instruction and has a mean score of + 0.8, y 0.1, — 12.0, to Froebel 45 with a mean class score of + 4.5, y 1.0, — 7.4. The summary of individual pupil + scores in each class shows that they range from 0 to 9, with 28 boys and 64 girls below their class mean, and 51 boys and 31 girls above their class mean.

The individual scores of Emerson class 15 as well as the total scores of all classes show that Part I of the test received the largest satisfactory response and Part II and Part III almost the same amount of satisfactory response. However, in Part I, point 4, which was a mis-

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cellaneous category, received more satisfactory replies than any other point.[1]

SUMMARY OF TESTS 8 AND 9

The individual and class scores on points which involve interpretation are much less favorable than were those which involve observation of objective phenomena, and recall of previous experiences. This result was of course to be expected since interpretation is much the more difficult process. Again, tests 8 and 9 are more difficult than tests 1 to 7, so that the lower scores in the former set do not necessarily indicate less ability. The inferiority in scores of girls to boys on tests 8 and 9 may possibly be correlated with the fact that in the Emerson and Froebel schools the boys were said to have had more instruction in elementary physical science and the girls more in household sciences. This explanation would not, however, apply to the Beveridge and Jefferson schools where no courses in elementary physical science had been taken by any of the pupils; yet in these schools the scores made by girls are lower than those made by boys just as in the Emerson and Froebel schools. The scores on test 9 of the Beveridge seventh grade class are low as compared with those of eighth grades in other schools. On test 8, however, the Beveridge seventh grade made a quite favorable showing as compared with the other schools. Tests 8 and 9 differ from one another in difficulty and the two tests together differ in difficulty from the other seven, and are of quite different nature. It is clear, however, that pupils in these schools show no marked ability to reply satisfactorily to tests 8 and 9.

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[1] This fact shows the need of a further refinement of the system of scoring these responses.

RECORDS OF EACH CLASS ON ALL TESTS

Charts have been prepared by means of which to determine the relative standing of each class on all of the 9 tests, and also charts which show the comparative response of all the six classes upon each of the 9 tests. These charts show considerable variation in the relative performances of the different classes. The Jefferson class has the highest mean score on 5 of the 9 tests; and the Beveridge seventh grade class has the lowest mean score on one of the 9 tests and ties for lowest on tests 1 and 2. The greatest divergence appears in the classes in the Froebel school. Five of the nine lowest mean class scores appear in one or another of these two classes, and three of the highest class means appear in a Froebel class. In tests 4, 6, and 9 Froebel class 45 ranks highest. It ranks lowest in tests 5 and 7 and ties for lowest on 1 and 2. The irregularity of attendance in Froebel class 45 undoubtedly helps to explain the scores, since, on the day when test 9 was given, 6 of the 18 pupils were absent; two were absent when test 4 was given and 4 when test 5 was given. When test 7 was given there were 5 pupils absent, but they were not the same pupils who were absent when tests 4, 5, and 9 were given. Five of the six pupils who were absent when test 8 was given were present when test 7 was given and these 5 made very low scores on test 7. The rankings of the 6 classes on all nine tests are in the following order: Jefferson, Emerson 14, Froebel 45, Froebel 46, Emerson 15, Beveridge.

The tests when grouped according to the chief purpose for which they were devised, it is repeated, are 1, 2, 4, 5 to discover abilities in observation and discrimination; 3, 6, and 7 to discover abilities to recall and use previous information and experiences; 8 and 9 to discover abilities to see what occurs and to interpret or give reasons for these occurrences. Summaries of scores grouped under these three headings show that on these particular tests the classes tested have highest rank on the second group; next highest on the first group, and lowest on the third.

The results secured by the tests are, as has already been stated, not wholly due to school work in science; they are affected by all the other influences, in school and out, to which children are subjected. Nevertheless, they would undoubtedly be better if the school work in science were more clearly planned and more efficiently conducted. On the basis of facilities provided, the Jefferson school should rank distinctly lower than Emerson and Froebel; but the superiority of Jefferson in its greater regularity of procedure and definiteness of program and purpose more than compensate for its inferior plant. If the Jefferson pupils could enjoy the Froebel and Emerson opportunities without losing their present advantages they would probably show still better results. They are not now better because of their limitations, but because the school makes better use of what it has.

The tests which were given to the last grade of the elementary schools were also given to the senior high school classes in the Emerson and Froebel schools. The charts showing the detailed scores for each pupil on all the nine tests are not presented in this report, but the comparative class scores are given. In the summary given in Chart XI[1] the results from 66 senior high school pupils and 174 grade pupils are presented. The four observation or discrimination tests are grouped together. In the same way the three tests on recall and use of information are grouped, and finally the two tests on interpretation or reasoning. The scores for boys and for girls are given both separately and combined. It will be noted that the mean plus score for the high school pupils exceeds that of the elementary school pupils in almost all of the 36 combinations presented, and that in the 6 cases where elementary classes score higher than high school classes, the difference is very slight in all but one case. In the observation and discrimination tests the elementary school girls slightly surpass the boys, and in these same tests the high school girls scored distinctly higher than the boys. In recall and use of information high school boys and girls had equal mean scores, while elementary school boys were markedly superior to the

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[1] See page 119.

CHART XI

Comparison of Scores on All Tests of High School Pupils, With Those of Elementary School Pupils

		No. of Test	Subject of Test	No. of Points	No. of High School Pupils	No. of Elementary School Pupils	Mean No. Points for High School Pupils			Mean No. Points for Elementary School Pupils		
							+	y	−	+	y	−
Observation and Discrimination	Boys	1	Elm—white oak	10	29	65	4.7	0.4	4.7	3.3	1.3	5.2
		2	White oak—red oak	10	29	64	3.7	0.2	6.0	3.2	0.6	5.9
		4	Kingbird—kingfisher	12	29	76	5.6	1.9	4.4	5.8	0.8	5.3
		5	Kingbird—flycatcher	11	29	76	5.6	1.1	4.2	5.6	0.4	4.8
				Mean score on this group			4.9	0.9	4.8	4.6	0.8	5.3
	Girls	1	Elm—white oak	10	36	85	5.1	0.5	4.3	4.0	0.8	5.0
		2	White oak—red oak	10	36	84	4.3	0.3	5.2	3.6	0.7	5.6
		4	Kingbird—kingfisher	12	37	96	6.0	2.0	4.0	5.7	1.2	5.6
		5	Kingbird—flycatcher	11	37	92	5.8	1.3	3.7	6.0	0.5	4.4
				Mean score on this group			5.3	1.0	4.3	4.7	0.8	5.2
	Boys and Girls	1	Elm—white oak	10	65	150	5.0	0.5	4.4	3.7	1.1	5.1
		2	White oak—red oak	10	65	148	4.1	0.3	5.5	3.5	0.6	5.7
		4	Kingbird—kingfisher	12	66	172	5.8	1.9	4.1	5.4	1.0	5.5
		5	Kingbird—flycatcher	11	66	168	5.7	1.2	3.9	5.8	0.4	4.6
				Mean score on this group			5.1	1.0	4.5	4.6	0.8	5.2
Recall and Use of Information	Boys	3	Bird identification	8	29	76	3.7	0.8	3.3	3.3	0.8	3.7
		6	Nesting birds	16	29	73	5.5	6.1	4.2	7.2	6.7	1.9
		7	Insects	16	29	75	5.5	5.9	4.4	3.8	6.9	5.1
				Mean score on this group			4.9	4.3	4.0	4.7	4.8	3.6
	Girls	3	Bird identification	8	36	96	3.6	0.8	3.5	2.9	0.9	4.1
		6	Nesting birds	16	37	91	5.2	7.0	3.6	5.6	6.7	3.6
		7	Insects	16	37	91	5.7	6.1	4.0	3.4	6.9	5.5
				Mean score on this group			4.9	4.7	3.7	4.0	4.7	4.4
	Boys and Girls	3	Bird identification	8	65	172	3.6	0.8	3.4	3.1	0.9	3.9
		6	Nesting birds	16	66	164	5.4	6.6	3.9	6.3	6.8	2.7
		7	Insects	16	66	166	5.6	6.0	4.2	3.6	6.9	5.3
				Mean score on this group			4.9	4.5	3.8	4.3	4.8	4.0
Interpretation or Reasoning	Boys	8	Smoke box	18	29	77	10.4	1.6	5.7	8.8	1.4	7.7
		9	Funnel experiment	13	29	79	5.4	1.5	6.0	3.4	0.7	8.8
				Mean score on this group			7.9	1.6	5.8	6.1	1.0	8.2
	Girls	8	Smoke box	18	37	91	9.3	1.5	7.0	8.6	1.2	8.0
		9	Funnel experiment	13	36	95	4.2	1.0	7.7	1.8	0.5	10.6
				Mean score on this group			6.8	1.2	7.3	5.1	0.8	9.2
	Boys and Girls	8	Smoke box	18	66	168	9.8	1.6	6.5	8.7	1.3	7.9
		9	Funnel experiment	13	65	174	4.8	1.2	6.9	2.5	0.6	9.8
				Mean score on this group			7.3	1.4	6.7	5.6	0.9	8.8

girls. In the interpretation and reasoning tests the mean scores of the boys in both elementary and high school were distinctly higher than those of the girls.

The total mean scores show throughout a higher score for high school pupils than for elementary school pupils. The difference is greatest in the last group of tests, i. e., those dealing with the more difficult matters of reasoning. The high school pupils had all studied one or more sciences in the high school, but it is not possible from the data to determine the amount of high school science studied, since the questions asked did not differentiate high school and elementary school science. It is possible that some of the higher scores in the high school may be due to the fact that some pupils remaining to the senior year of the high school are persons of superior ability, but it is equally possible that pupils who do not remain to the senior year also possess superior ability. While it is not proved, therefore, that the higher scores of high school pupils on these tests are due to their high school science training, it is likely that this is true.

XI. PUPIL HELPERS IN SCIENCE WORK

IN THE preceding account frequent reference has been made to "pupil helpers," and since the "helper" plan is used in science quite freely, a word should be devoted to it in this connection. When a pupil from a lower class is assigned to work with a more advanced class he is known as a "helper." When a pupil from a more advanced class works with a lower class he is known as an "assistant." The theory of the helper plan, as has already been stated, is that a younger pupil learns something, and gains much stimulation, when he observes the work of older pupils. Teachers usually underestimate the amount of real understanding which immature pupils may secure of work ordinarily considered too advanced for them. Such work may also arouse desire for further study. Adults who have been pupils in district schools often testify to the amount of information and interest gained by them through listening to the recitations and discussions of older pupils. It seems likely that with our modern definite classifications and separately taught classes we may lose much that might be gained through contact with older pupils. The helper plan is designed partly to supply this need and no doubt has value.

But to be of real educative use, helpers should not be merely kept in the same room with the older class, but should have some opportunity to participate, if no more than enough to avoid the deadening effect of sitting idle for a whole period in a room where no obligation or responsibility rests upon them. In case of some kinds of shop work, science laboratory work, or garden and poultry work, the helpers should be kept engaged as real helpers to pupils who are primarily responsible for the work in hand. In a system of duplicate classes the need of disposing of some pupils for one or more periods sometimes leads to the abuse of the helper plan by assigning pupils day after day as helpers in classes where they do no more than sit or wander about the room idly until the close of the assigned periods. The most serious danger of the system is that it may foster a habit of carelessness, of time wasting, of irresponsibility. There is abundant evidence that this danger is not always avoided. The benefits of the plan, now only occasional, could be more frequently secured, if pupils were assigned as helpers only at times and in places where they may really learn something and really help; at all other times they should be profitably engaged elsewhere.

XII. CONCLUSION

WE HAVE stated that science is still in most schools grudgingly treated in the way of time, facilities, and supervision, and that science materials make too feeble an appeal to children largely because they lack concreteness. Gary has been comparatively generous in giving time and providing equipment, and has thus explicitly stamped the subject as important.

It is, however, quite impossible to characterize the instruction in general terms. Here and there—notably in some of the high school grades of the Emerson school—it was good, that is, the instructor pursued an orderly plan in choosing and arranging material and constantly sought to show the way in which science principles and science knowledge are used in the affairs of modern society. The pupils were interested, but they were more than interested—they were being trained to think and act effectively. The teaching of botany and gardening at the Froebel school was in a high degree intelligent and effective; while not deficient in scientific order, it nevertheless kept in close contact with the facts and needs of life. Elsewhere, however, the instruction was too frequently formless and aimless. It had often abandoned the safe though usually dispiriting support of the textbook, without finding other safe plan or guidance, and was often less effective than conventional work would have been.

The lack of continuity and of organizing purpose to which attention has been frequently directed is fatal to good work. Even science teaching of conventional type cannot run itself; still less so, science teaching which abandons the beaten path. Supervision and staff organization, necessary under ordinary circumstances, need to be more efficient and more intelligent, if they are also to be more flexible, as under the conditions that obtain at Gary. But Gary's science supervision is nominal and its staff conferences far too rare to answer their purpose. Under such circumstances, conventional teaching would be unlikely to be good of its kind; and a large experimental undertaking when so conducted is likely to have an unsatisfactory result.

Gary has, however, shown courage and resourcefulness in trying to free science teaching from its remote and abstract character, in trying to bring it into touch with the pupil's experience and to relate it to his other school work. Teachers of English and teachers of science attack a large problem together; the shop and the laboratories are at times brought to bear on identical problems. This is excellent as far as it goes, and contains the foundation upon which a rational course in school science may ultimately be worked out. But it is not enough merely to break away from the formal, cut-

and-dried type of science teaching represented by most textbooks and to introduce concrete problems from time to time. Chaos follows unless aims have been sharply defined; unless orderly development of laws and principles is assured through intelligent and forceful guidance; unless careful and exacting work is secured through competent teaching. Beyond a general and sound predilection for the concrete as embodied in the environment and experience of the pupil, it is impossible to discern at Gary satisfactory principles of organization or progression in science teaching. Unquestionably, the children are interested in their science work and derive pleasure from it, and to this end the work is of value. But science fulfills its educational mission, not simply by arousing interest in a disconnected series of phenomena or giving pleasure through a disconnected series of experiences, but by cultivating capacity to deal intelligently and vigorously with significant problems. This ought indeed to be both an interesting and a pleasurable task; but unless it involves order, persistence, and hard work, its educative effect is probably of minor importance. Unless so presented, science is likely to be a transient diversion rather than a profoundly formative and truly disciplinary influence in the pupil's development.